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# THE FUNDAMENTALS OF ANIMATED SCIENTIFIC DRAWING AND CINEMATOGRAPHY*†

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*Importance of a knowledge of photography.* Animated drawings are playing an important part in scientific illustration. Their production is so highly technical that it becomes a specialized field within itself. For this reason such a study cannot be treated as fully in this text as is necessary to give a complete working knowledge of the subject. This is particularly so because the artist who intends to make acceptable animated drawings, in addition to his knowledge of art should understand the fundamentals of photography, especially motion picture photography. These fundamentals embrace: lens action, such as focusing, focal length, and speed of lenses, as well as exposure; the mechanics of the time lapse motion picture camera; and, finally, the technic of the processing room, for it is here that many interesting and necessary animated effects are produced with chemicals and the printing machine. This, of course, would hold good only for the artist who does his own camera work. However, it is advantageous to learn the fundamentals of the entire process. For the animation worker photography and drawing are so interdependent that a description of one is inadequate without a description of the other.

*Movement.* Animation provides a means of obtaining motion pic-

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tures which cannot be produced by ordinary cinematography. In other words, animated drawings accomplish the same purpose for the motion picture that an ordinary drawing accomplishes for the textbook. The production of such pictures requires a knowledge of the elements of motion, and the ability to analyze a movement and divide it into its proper phases or steps. This must be taken into consideration and planned before the drawing is attempted. Plans of procedure must be established for each complete movement, also the method by which such a movement may be accomplished, before drawings are made. In short, a complete plan of procedure must be made and set down in the form of a scenario on paper before proceeding. This scenario should show the footage necessary for each scene.

FIG 1. PHOTOCHRONOGRAPH OF A WHITE DUCK IN FLIGHT

This illustration shows clearly different phases in the action of the wings for the completion of one definite movement. In drawing, the steps may be increased or decreased to create a change in the time the action takes place. From Marey 1901.

*Frames.* Every foot of standard motion picture film is made up of sixteen separate pictures. Each picture is called a *frame.* When it is projected at normal silent speed, which is one foot or sixteen frames per second, the action which takes place should run smoothly providing it was taken at that speed, or providing it was animated in the proper manner to fit this projection speed.

*Taking and projection speeds.* Before sound pictures were universally used, sixteen frames per second was standard taking and projection speed. It was later found that the average theatre audience could grasp the action of the pictures faster than it actually took place. This time-drag was overcome by projecting the pictures that were taken at sixteen frames per second at about twenty frames per second. This, naturally, made the action faster on the screen.

With the advent of sound pictures it was necessary to have the film pass through the camera at an even faster rate of speed to obtain good

sound recording. So the *taking* and *projecting* speed was increased to twenty-four frames per second. Since both the taking and projecting speed are now the same, the action takes place on the screen at the same rate of speed at which it was photographed or acted. However, in the case of animated drawings, the drawings are changed or moved to represent the action. Therefore, the taking speed will vary greatly from the projecting speed for the drawings must be photographed one frame at a time. In this article sixteen frames per second will be considered as normal projection speed. This is no great disadvantage should the occasion arise to add sound to the film, for it is possible to increase the number of frames in a special motion picture printing device and still preserve smooth running action. In other words, action that took place in one second and was photographed on sixteen frames can be increased to twenty-four frames and projected in one second after the sound has been added. This method is not suitable where the sound must be perfectly synchronized as, for example, the synchronizing of sound to lip movements.

Before attempting to make an animated film the artist should obtain from one source or another a piece of film made by a professional animation artist. This need not necessarily be of a scientific nature; in fact, a piece of film from one of the animal comedies such as "Mickey Mouse" will suffice. Study this film carefully to determine just how the action is developed. In figure 2 is seen an action that has been condensed into five frames. Should this film of only five frames be projected at normal speed the action would take place rather suddenly. It may be prolonged on the screen by extending the number of frames. Frames can be duplicates or triplicates. However, in most cases each or every other frame should be different from the preceding one, or further progressed in action. Otherwise, the action is apt to be jumpy or to flicker on the screen.

While most ordinary motion pictures are scored with sound at the same time they are taken, animated films are never synchronized to sound at the time they are animated. This is done before the animation is begun or after it is completed. However, the artist generally has a good knowledge of the sounds or spoken words that are to accompany his animation and he develops it accordingly. The lecture part for a given sequence is usually timed by a stop-watch in several reading trials. The time required determines the footage within which the

animator must accommodate his work. A compromise is frequently necessary. If, as often happens, the lecture is an afterthought, timing is made up on "holds" of still phases. It is well to make all pictures so as to permit easy synchronization.

*Drawing materials.* The materials necessary for making this type of drawing should be carefully considered. A good grade of bond paper, sheets of celluloid and India ink are suitable for plain line drawings for

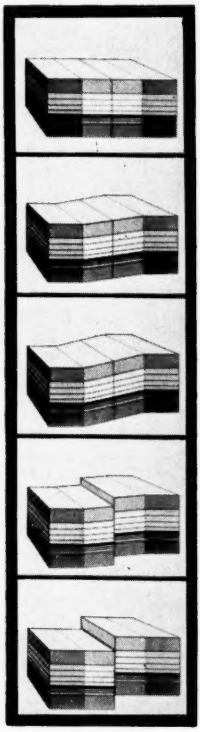

FIG. 2. AN ACTION CONDENSED INTO FIVE FRAMES
(By permission J. A. Norling: *Animated Drawings.* Jour. Bio. Photo. Asso., 1933, Vol. 1, No. 3, p. 125.)

animation. This paper and celluloid should be cut into a convenient working size, with two holes punched in them to fit pegs on a specially constructed drawing board which will be described later. The size of the paper and celluloid is seldom smaller than $7\frac{1}{2}$ x 10 inches nor is it larger than 14 x 22 inches. However, it may be any size for a stand with a zooming arrangement. Its proportion is approximately the same ratio as a standard motion picture frame, which is $\frac{3}{4}$ x 1 inch.

Besides the India ink, graded washes (of India ink and Chinese white) are often prepared for use on backgrounds in areas that are not to show movement, or flat tones on parts that are to be animated. These latter tones must remain flat and be of the same tone throughout the action. Otherwise, a constant changing or flickering of the tone will appear on the screen.

*The drawing board.* A necessary piece of equipment is a specially prepared drawing board. This board (fig. 3) is mounted on a base and has an oblong portion cut out of its center, over which is placed a piece of clear or ground glass. The latter will give more diffusion of the light that is constructed beneath it. Above this glass are fixed two steel pegs. These serve to hold two or more sheets of paper, celluloid, or both in register. In other words, several sheets can be placed on the board and each will be accurate in relation to the others. Thus a drawing in progress can be guided by the drawing that lies beneath the sheet that is being worked on.

*Backgrounds and moving parts.* The simple use of the material is as follows: The background is laid out and within its limits the general action of the characters or the moving parts is to be confined. The animated characters, instruments, or other moving objects are drawn in pencil on white paper. These pencil drawings are then traced upon thin sheets of celluloid in India ink. The sheets of celluloid are painted behind the drawing on the other side of the sheet with opaque water or tempera tones. This idea of opaquing the back of the transparency is the key to the use of celluloids.

*Short cuts.* It is also obvious that unless many short cuts are devised the art of making animated drawings would not only become quite complicated, but tedious as well. For this reason, the artist takes advantage of various processes to assist him in his work. Ordinary photography, printing, photostating and projected images come to his aid when he finds that he has to produce a great number of drawings all indentical except in some minor detail. These processes save him laborious repetition in drawing. The best animator is not necessarily the one who spends considerable time on each drawing. On the contrary, he is a person who can visualize the picture as a whole, eliminating useless detail and drudgery in achieving the desired result. If he is guided by an effort toward simplification his result will be far more pleasing and understandable to the audience than if he tries to produce complicated detailed work.

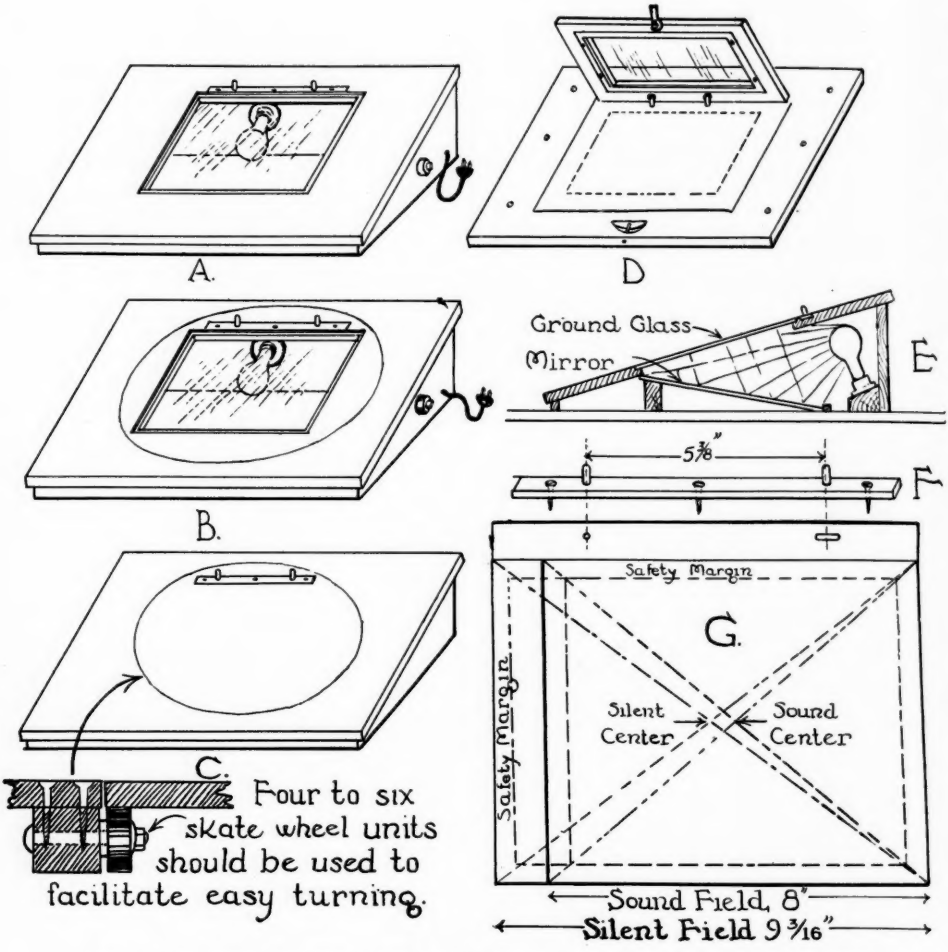


FIG. 3. DRAWING BOARDS USED FOR MAKING ILLUSTRATIONS FOR ANIMATED MOTION PICTURES

*a*. Simple drawing board with clear or ground glass over mazda bulb.

*b*. Drawing board in which the glass can be placed at any angle for convenience of drawing by rotating center area.

*c*. Drawing board without glass, the center of which rotates for convenience of drawing at an angle. The sketch shows how skate wheels can be utilized in the boards shown in *a* and *b* for obtaining the desired rotation. Six or more wheels are necessary.

*d*. Frame used under the motion picture camera for copying the drawings. The glass plate keeps the celluloids and paper in good contact.

*e*. This shows another method of placing the electric light bulb and the use of a mirror to obtain more even illumination. If so desired a ground glass can be placed between the bulb and the mirror for perfect diffusion of light.

*f*. This shows a metal peg that is used at the top of the drawing board and copying board.

*g*. Shows the usual paper size for both sound and silent film.

Mr. J. A. Norling (1), who so graciously furnished some of the drawings herewith reproduced, writes as follows:

"Most animated drawings are made on celluloid sheets as this transparent material allows the use of a fixed background. Let us consider Figure 4 in which the pencil drawing is first made on paper, then traced on celluloid with India ink. The open spaces within the figure are painted in on the back of the celluloid with opaque colors of the desired shade. In "A" we have the pencil drawing; in "B" the celluloid tracing which has been "opaqued"; in "C" the wash drawn background; in "D" the celluloid on the background in position for photographing."

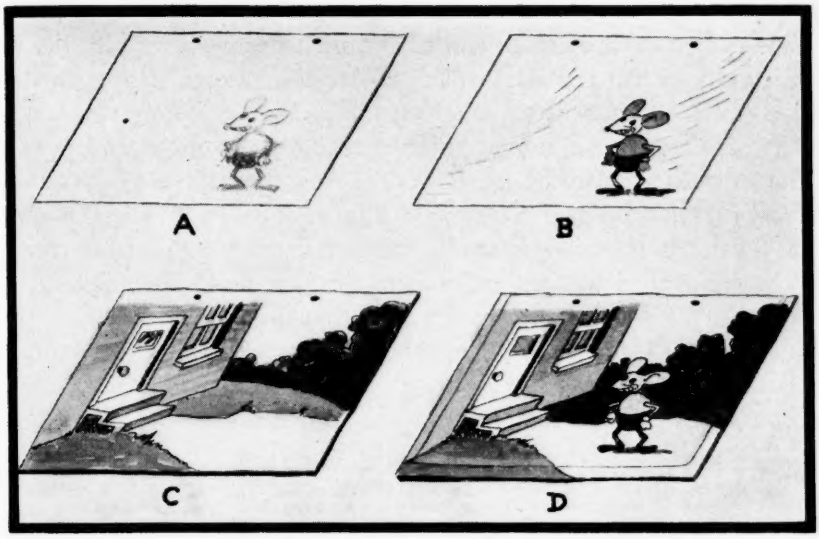


FIG. 4. USE OF CELLULOID

*A*. Pencil drawing. *B*. Celluloid tracing which has been opaqued. *C*. Wash drawn background. *D*. Celluloid on background in position for photographing.
(By permission J. A. Norling: *Animated Drawings*. Jour. Bio. Photo. Asso., 1933, Vol. 1, No. 3, p. 125.)

*Progressing in action.* To make the drawings progress in action, the first of the series is drawn in the same way as the top frame in figure 2. A sheet of paper or celluloid is placed over this drawing and a second is traced from it, adding another step in the action. This is continued until the action is completed. Such a method requires a considerable number of drawings. However, the skilled artist can make the first drawing of an action and have some other artist or student who is less skilled make the tracings. Naturally this student should have a good idea of the action he wishes to create in his tracings, which, in

reality, are more than tracings in the sense that bits of original drawing are often added as the action progresses. When the scene radically changes it becomes necessary for the skilled artist to work on the main sketch again and give the assistant full directions for proceeding.

*Cutout sections.* Often drawings may be used again and again in developing the animations. For instance, let us consider an operation on the abdominal cavity. A background drawing of the incision and surrounding tissue may be made on paper. The part that shows the opening may be drawn on celluloid as this is likely to change from time to time. Instruments may be drawn on thick drawing paper and their outline cut out. The drawn and cutout instrument may be moved intermittently across the background under the camera to express the action of the instrument approaching the incision. However, it is best to have it drawn on separate sheets of celluloid and fitted in sequence in the animation. This insures correct photography of the entire action.

*Planning and testing the animation.* Figures 5a and b show background plans for making tests to determine the required action in an animation for the removal of foreign bodies from the bronchus. It is helpful to make such plans before proceeding with the finished drawings for the actual work. This sketch shows the position of the patient on the operating table ready to receive the instruments that are to be inserted in the trachea through the open mouth. These instruments are drawn on thin cardboard and cut out along their outline. A slit was cut in the background drawing (fig. 5a) between A and B along the edge of the open mouth. The drawn instruments were made to approach the mouth intermittently by animation under the camera. The end of the instrument was inserted in the slit and animated further, giving the appearance of being passed down the throat. This procedure gave a good impression of how the operation looked from the outside.

For a further animated illustration of the procedure that took place on the inside of the body, a sagittal section through the midline of the body was drawn as seen in figure 5b. Since this was only a plan no effort was spent in developing a finished drawing. Such preliminary sketches serve only for the purpose of mapping out action. When this is done finished drawings are made for the actual animation. To continue with figure 5b, it was discovered that the tip of the epiglottis had to rotate forward to allow the instrument to proceed down the trachea. To accomplish this a separate drawing of the epiglottis was made and

cut out as seen in A. This was attached in position with a single pin which acted as a pivot and axis. The epiglottis could then rotate on this pivot. As the instrument came in contact with the tip of the epiglottis the instrument and the epiglottis were moved forward, allowing the instrument to go down the trachea. When this action was properly animated it gave the impression of the instrument passing into

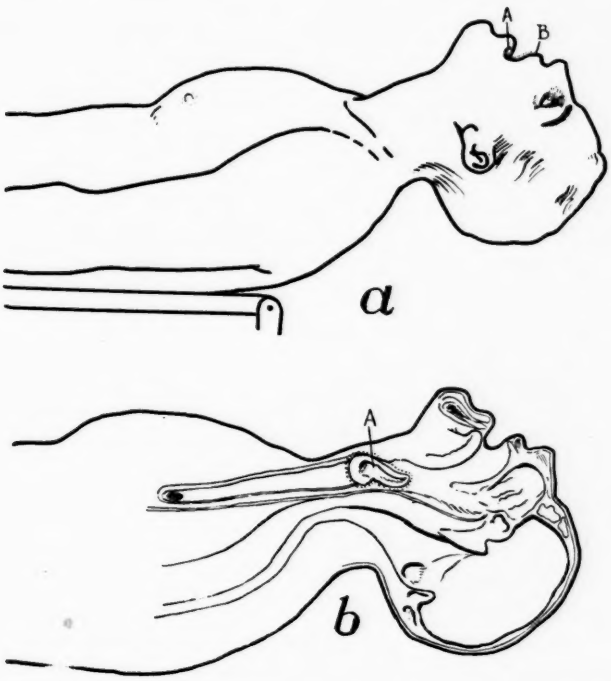


FIG. 5.

*a*. Plan of background for test in determining the action on the outside of the body for the removal of foreign bodies from the bronchus.

*b*. Plan of background for test in determining the action on the inside of the body for the removal of foreign bodies from the bronchus. The dotted line represents the "cut out" epiglottis area.

the mouth, coming in contact with the tip of the epiglottis, and forcing the tip of the epiglottis forward and out of the way to allow the instrument to pass down the throat.

Another test was made on this same type of subject which consisted of making a life size drawing of the midline sagittal section with the cutout and pivoted epiglottis. The drawing was laid flat on the anima-

tion apparatus for taking the film and the surgeon used the actual instruments for completing the animation. This saved considerable time in the making of drawings. In the same manner animation was developed for the removal of foreign bodies from the esophagus.

*Preparing the drawing.* Anyone who has a reasonable amount of talent for drawing can develop his ability to make satisfactory technical animation if he studies and analyzes the movements involved. The quality of a drawing for animation does not depend upon elaborate and detailed rendering, but upon clear, sharp and bold delineation. All drawings, whether shaded in line, pencil dust, wash, charcoal or airbrush, should be made in bold contrasts so that they will appear brilliant and in bold relief when projected upon the screen. Just as the commercial and scientific artist must learn to draw for reproduction by various photomechanical processes for printed publication, so must the animation artist learn to draw for reproduction on motion picture film.

*Timing the action.* As a hypothetical case consider the animation of such a movement as extending the arm and drawing it back. Further, this action is to be on the screen for approximately five seconds, which ordinarily should be enough time for this procedure. The complete movement of the hand out and back should take place in one second. To accomplish this seven pictures of the arm are drawn, each on a different sheet of paper. These drawings express the action seen in figure 6 from A to G. In making these drawings, A is made first, then a sheet of paper is placed over A and the outline of the shoulder and upper arm is traced. The lower arm and hand are copied at a slightly greater angle with slight changes in the bulge of the muscle. This is continued through C, D, E, F and G. Before photographing these drawings the time within which the action is to take place on the screen must be predetermined. Suppose the arm is to move out and back rather rapidly. In such a case, A is placed in the glass frame under the camera and *two* frames of the film are exposed. Then B is put in its place and only *one* frame is exposed, and so on with C, D, E and F. Then G is exposed on two frames. Now reverse the order and expose the same pictures, F being the next to be exposed on one frame, and so on to A, which is exposed for a second time on two frames. You will find that sixteen frames, or one foot of film, have been exposed, which will run only for one second on the screen. However, as stated in the beginning, this action is to be shown for five seconds on the screen, therefore

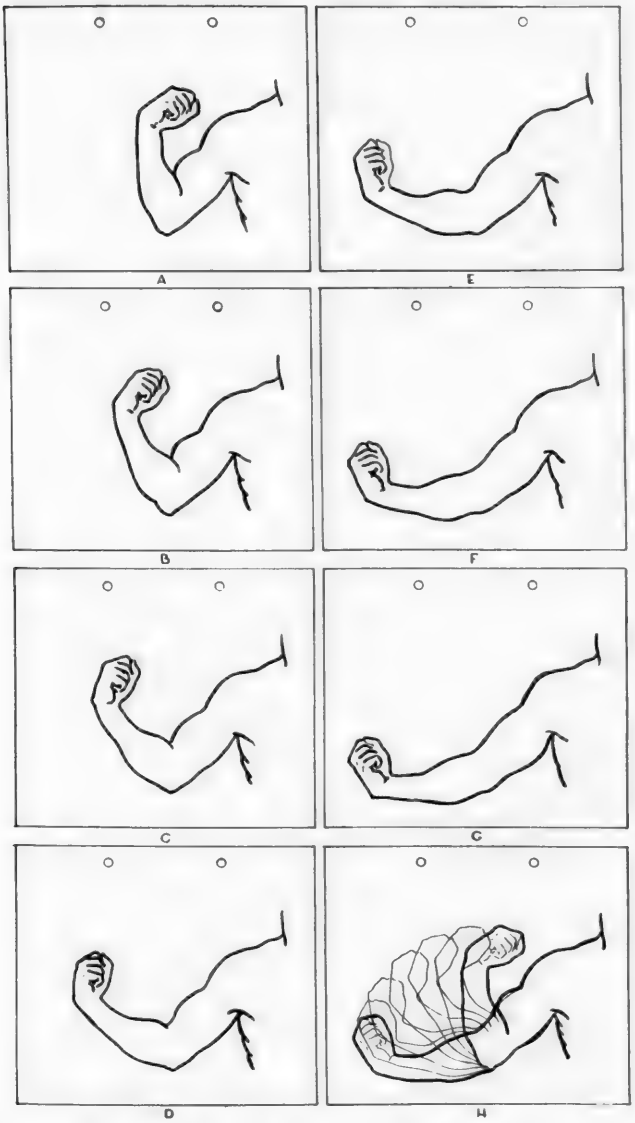


FIG. 6. AN ACTION DETERMINED IN SEVEN FRAMES
Part H of this figure shows the positions these drawings would take in animation.

the same procedure is repeated for five consecutive times. When these five feet of film are completed it will be found in projection that there is a pause when the arm is drawn back. The action will be comparatively fast; the complete movement of the hand out and back will take only one second.

Suppose it is desirable to have this action take place in twice the amount of time, in other words, the action is to be slower. To accomplish this expose each picture on twice the number of frames. This is apt to show a slightly jumpy action, but not sufficiently jumpy to be irritating to the audience.

If this action is to be shown for a longer period of time on the screen, simply continue the action for more footage. Figure 6-H gives the impression of how these pictures would look if they were all superimposed on each other.

*Presenting the subject before starting the action.* While the above description was given merely to show how an action is developed, it is not always desirable to begin the picture with action as soon as it reaches the screen. It is far better to take one to three feet of film of the first picture before the action begins. This gives the audience time to grasp the entire idea of the scene before the action is shown and also uses up footage, eliminating unnecessary animation.

It is always best, especially for the beginner, to make tests from time to time by animating drawings under the camera and projecting them after development and printing to see if the action runs smoothly. Even the well-trained and experienced professional animator occasionally feels sufficiently uncertain about his ultimate results to make test drawings and exposures. A group of the drawings also may be held in the hand and "flipped," as one rapidly turns the pages of a book, to determine if the action is smooth and proper.

*Examples of animation.* The animation of a man talking and moving his hands can be produced in two main drawings and a few auxiliary drawings of the moving parts. One drawing is of the man only, which is made on celluloid. On the back of this celluloid sheet the man's body is filled in with opaque white paint so that the background will not be visible through his body. Part of the face and the hands are left blank. The other picture is of the background, which is drawn on paper. The auxiliary drawings, which are drawn on celluloid and backed up with opaque paint, are of the hand and that part of the face which moves

and is missing in the first picture. This action can actually be accomplished in three drawings. To save time in drawing, the parts that move are the only parts changed. Each of these three auxiliary drawings shows the mouth and hand in slightly different positions. By photographing them in rotation, and reversing them as has been described in

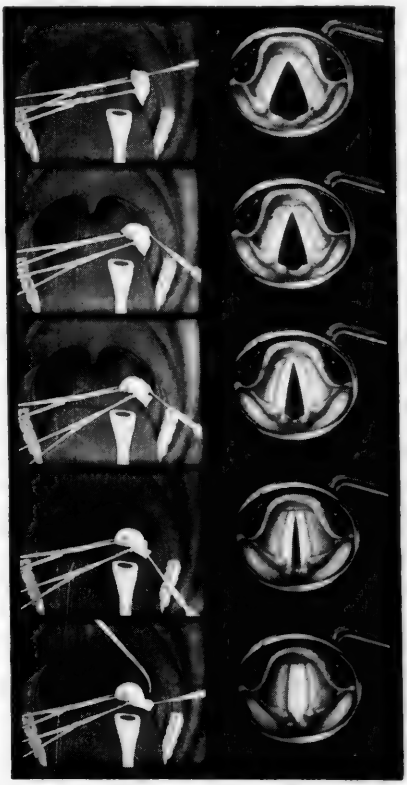

FIG. 7. EXCELLENT EXAMPLES OF MEDICAL ANIMATION
(By permission K. K. Bosse: *The Use of Animated Drawings in Medical Motion Pictures.* Jour. Bio. Photo. Asso., 1933, Vol. 1, No. 3, p. 117.)

raising and lowering the hand, it can be arranged to have the man talk for the time desired. Such animation was used when words were hand printed in talk *balloons*. However, with the addition of sound to film, it became necessary to make the mouth of the speaker take the shapes it assumes when actual words are formed and spoken. Naturally this complicated matters, but the clever artist was soon able to produce

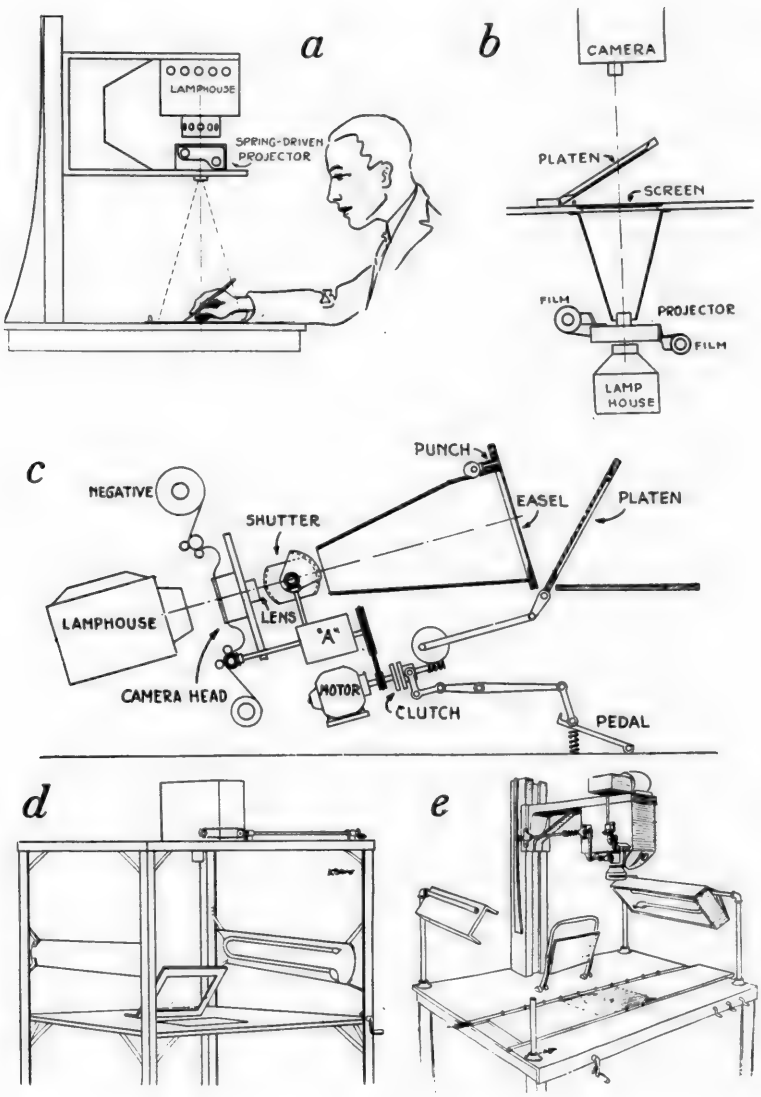


FIG. 8

*a*. Device for tracing projected motion pictures.

*b*. An apparatus for photographing a composite single frame projection and cartoon drawing.

*c*. Device for making single frame enlargements on paper.

*d*. An early type cartoon stand.

*e*. Animated cartoon stand. (By permission from J. A. Norling and J. F. Leventhal: *Some Developments in the Production of Animated Drawings*. Tr. Soc. Mot. Pic. Eng., 1926, No. 25, p. 58.)

animated drawings that synchronized with the spoken words in the script.

Figure 7, which is reproduced from Mr. K. K. Bosse's article in the March, 1933 issue of the Journal of the Biological Photographic Association (2), gives an excellent idea of examples of medical animation. In the picture to the left, the part in half-tone evidently represents the single drawing for the background. The flat white instruments and tonsil are the parts that show action.

The still part here is the speculum and the pharyngeal tissue is at the right and left of the epiglottis; all the rest, being everywhere in motion, is *overlay*. It was due to the amount of work involved in making half-tones for animation that so small a number were used.

The action of the picture to the right could have been developed in six drawings, the background comprising everything except the vocal chords and the tissues directly to their right and left. The action of the chords and this tissue could then have been developed in the remaining five drawings. It would be possible by continuous animation to produce the desired length of film for this scene.

*Combining photographs and drawings.* There are also other methods of reducing the time in making the comparatively great number of drawings necessary for a complete reel of animation. Such devices are pictured and described in an article written by J. A. Norling and J. F. Leventhal (3). These authors show the picture as seen in figure 8a and give the following description for combining straight photography with technical animation.

"One of the most interesting of recent developments is the combination of cartoon and straight photography. The three methods in most common use are double printing, double exposure, and the making of enlargements from film. In double printing two sets of drawings of each action must be made and registered accurately. These drawings are animated on white paper upon which is thrown an image of the regular photography motion picture with which it is desired to combine the animated cartoon character. The device for projection and tracing is shown in Figure 8a. The image is projected down upon the paper, and the drawings are made to fit with the action of the straight photography characters. Two negatives are made of the cartoon and double printed to secure the desired effect."

*Combining the drawing with the projected image.* These authors also give another method shown in figure 8b and accompanied by the following description:

"The second method consists of photographing a projection from a print of the photographed actions with which combination is desired. A device for doing this is shown in Figure 8b. The image is projected up and through a transparent screen. There is no illumination except from the projector, of course. The celluloid containing the drawing is used for a mask, and the projected image is photographed by the camera above. The resulting negative, if developed at this stage, would leave a blank space where the drawing has masked off part of the projected image. The negative, however, is wound back in the camera, and another exposure is made. This time the lights are turned on, a black card inserted under the celluloids that carry the drawings, and an exposure made. Only the cartoon character is exposed in the place left blank by the mask in the first exposure. The background being black reflects very little light back to the film, and this exposure from the black card is slight. The negative resulting from these two manipulations thus contains the combined actions of cartoon characters and real characters. The quality of the print is often very good except for a slight graininess, which, however, is not quite as pronounced as the graininess in a duped print."

*Photographic enlargements for combining with drawings.* The same authors continued with their device for making single frame enlargements on paper to be used in the production of animated drawings. Their apparatus is shown in figure 8c, and they give the following description:

"The third method simplifies the work for the artist. In this method, enlargements are made from a straight photographic negative, upon which he can work directly. It would seem at first thought that enlargements made from each frame of the negative would be prohibitive in cost, but by merely applying some well-known principles of quantity production, this cost can be kept within reasonable limits.

"The device for making enlargements from motion picture negatives is shown in Figure 8c. This machine is semiautomatic in action and works somewhat like a printing press. A camera head connected to a 1-to-1 device feeds the film from one frame at a time. The feed is actuated by a motor-driven tripping device. The paper, usually glossy bromide, is placed upon the easel (face toward the light) and the clutch thrown in, thus bringing the platen against the paper and throwing the punch into operation. The punch makes the necessary registry holes while setting an electric switch which actuates the tripping mechanism that revolves the exposure shutter. The platen is now withdrawn, and another frame of film automatically brought forward in the camera head. Everything is then in readiness for the next exposure. It is possible to make 500 enlargements an hour with one of these machines. The enlargements must be developed in quantity to insure uniformity of tone; therefore, racks holding 100 sheets are used. The rack is immersed in a tank of developer and properly stirred. The succeeding washing and fixing operations are carried through without removing the paper from the racks. The enlargements are dried on ferrotype tins. If properly made, they retain most of the photographic quality of the original

negative. The animated figures upon sheets of celluloid are laid over the enlargements and the composites exposed in the cartoon camera. If the enlargements are made from a negative of high quality, the resulting film will be surprisingly good photographically; quite unlike the results obtained in the common practice of duping.

"Unique and lifelike animation may be obtained by reproducing in line drawing a figure photographed in real action. A tracing machine, consisting of a projector which throws an image of the film upon a sheet of paper, is used. The artist traces the outline of the figure in the successive phases of motion. The subsequent operations to produce the finished product follow standard practice."

*The taking equipment.* Now consider the photographic apparatus necessary for reproducing the drawing on motion picture film. Drawings are photographed in a frame similar to the one seen in figure 3d. This frame has two pegs to correspond in size and placement to those on the drawing board for the proper registration of the drawings on celluloid and paper. The glass in the frame should fit snugly against the drawing so that both celluloid and paper will be in absolute contact, otherwise an undesirable shadow will be cast from some of the lines on the uppermost piece of celluloid to the background below. To prevent this the glass, which should be about one-fourth of an inch thick, can be bored with four or eight holes which are also countersunk. The glass is then attached with flathead screws to a molding which is tacked to the inner edges of the opening in the frame.

The Bell and Howell Company have placed on the market a comparatively simple animation stand which provides a self-contained unit for making animated drawings, maps, film-slide negatives, titles, etc. on 35 mm. film. This stand, figure 9, consists of a Bell and Howell Eyemo spring-driven 35 mm. camera which can be raised or lowered; two Photoflood lamp reflectors; a single frame exposure trigger; and provisions for centering and framing the subject.

J. A. Norling and J. F. Leventhal, in their aforementioned article (3), show a picture of an early type of animated cartoon stand as seen in figure 8d. The camera of this apparatus is set at a fixed distance from the copying board. This makes it necessary to change lenses of different focal length on the camera in order to make the picture on the frame of the motion picture film either larger or smaller. In other words, it is impossible either to raise or lower the camera to vary the size of the picture. However, this is one of the most simple devices for such equipment, and is well worth consideration. Cooper-Hewitt tubes are used for the illumination in this apparatus. However, they are not necessary as

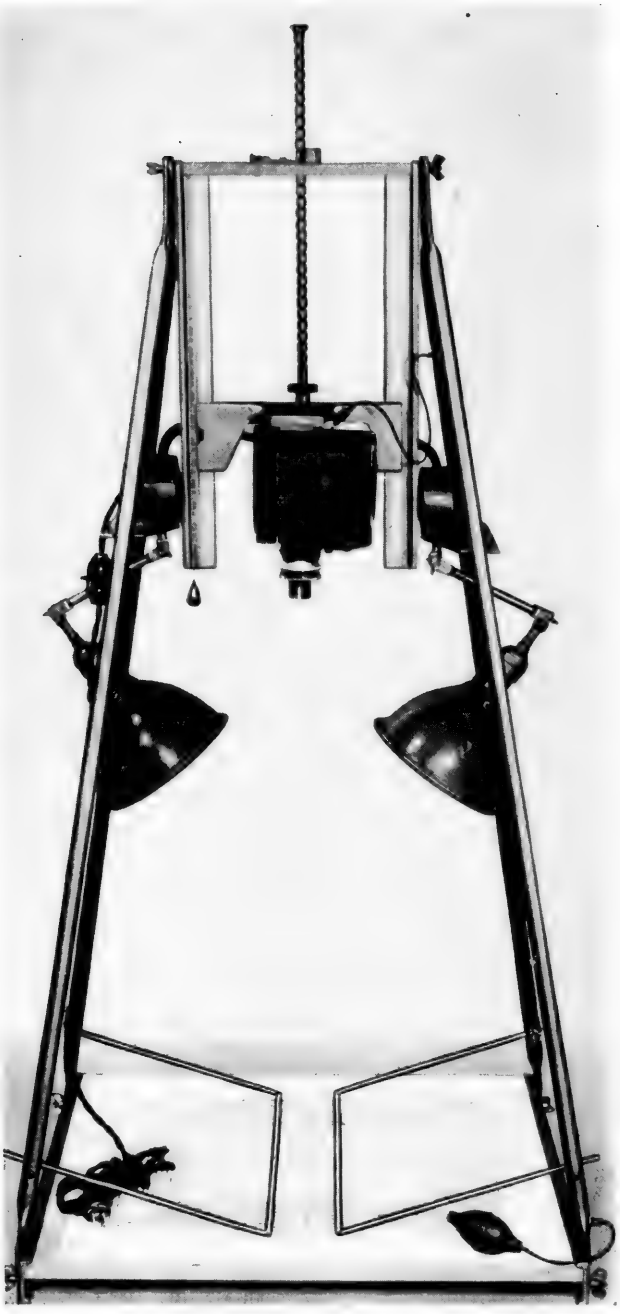

FIG. 9. BELL AND HOWELL ANIMATED CARTOON STAND
(Courtesy Bell and Howell Co.)

banks of incandescent bulbs will serve as well. *The correct exposure of film must be determined regardless of the type of light source used.* Since the picture does not move during exposure, small diaphragm openings can be used which necessitate comparatively long exposures.

FIG. 10. MODERN CARTOON STAND

(By permission J. A. Norling: *Animated Drawings.* Jour. Bio. Photo. Asso., 1933, Vol. 1, No. 3, p. 125.)

Messrs. Norling and Leventhal have developed a more perfected camera equipment which they report in the same article mentioned in this text. They give the following description:

"Figure 8e shows one of the latest (September, 1926) installations operated by mechanical means and adjustable for various sizes of drawings, whereas the camera in the old stand was fixed. This stand is equipped with an automatic focusing device,

automatic actuating mechanism for moving the film, automatic dissolving shutter, mechanical sliding panoram, and a number of other things. All contribute to the efficiency of the device and make possible startling effects, impossible to achieve on the older and simpler installations."

This last apparatus was reported in September, 1926. Since that time Mr. J. A. Norling (1) reports an apparatus that is an improvement over the equipment. He gives the following description:

"A description of a more elaborate equipment may be interesting to the advanced worker. Figure 10 shows such an animation stand which is capable of handling all types of work. It is adjustable to take drawings from 3 x 4 inches up to 30 x 40 inches.

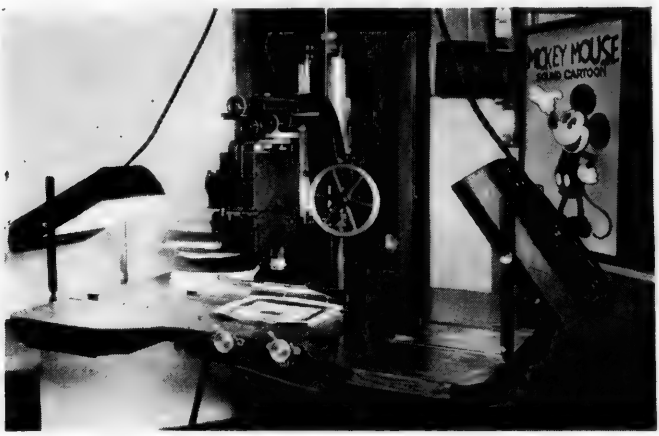


FIG. 11. ONE OF THE ANIMATION STANDS USED BY THE WALT DISNEY ENTERPRISES

The camera is motor-driven and controlled by an electromagnet actuated either by a hand switch or a foot switch. The motor drive may be reversed for photographing drawings in reverse order.

"An outfit of this kind allows 'zooming' down to a portion of the drawing to show a closeup. Double exposure and all sorts of trick effects are possible. The camera is equipped with four lenses of different focal lengths, so that by merely swinging the lens turret around, long shots and closeups can be made without elevating or lowering the camera. A motor-driven screw is used to facilitate the raising or lowering of the camera.

"For double exposure work, such as may be required in making composite animation on an actual scene, a camera of the utmost precision must be used. The camera shown here is a standard Bell and Howell professional model, which is best for such work. It is provided with registration pins and a shuttle movement which locks each

frame into place for each exposure. This provision is absolutely necessary to obtain the perfect 'matching' required in composite photography."

A comparatively simple taking apparatus as seen in figure 12 was developed by the author at the University of Maryland. The camera

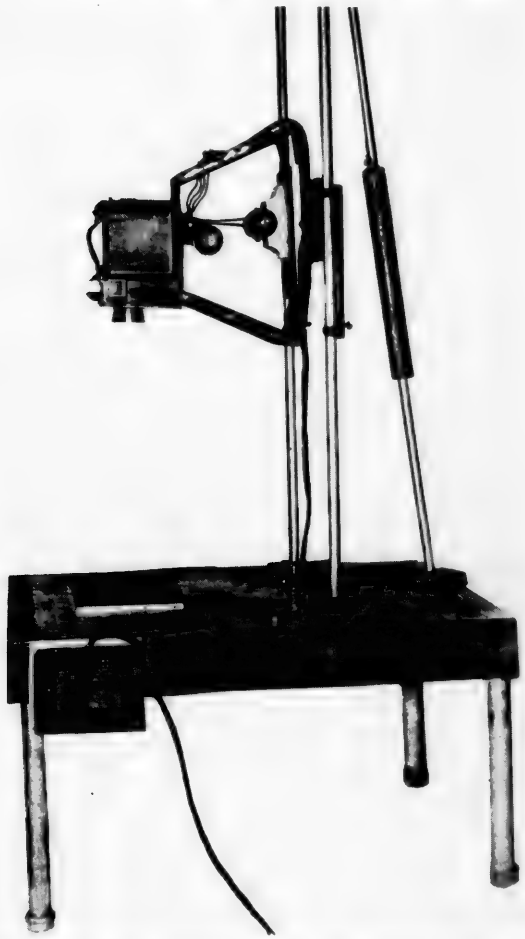

FIG 12. AN APPARATUS USED AT THE SCHOOL OF MEDICINE OF THE UNIVERSITY OF MARYLAND

is supported by three rigid, upright pipes which permit the raising and lowering of the camera mechanism that is counterbalanced. The camera is driven by chains from a system of gears which, in turn, are driven by a belt from an electric motor. Incorporated with the gears are two

switches. These switches operate in synchronization with the shutter of the camera and a small light on the control board shown in the lower left-hand corner of the picture. The automatic switches prevent the stopping of the camera while the shutter is open, thereby eliminating the possibility of prolonging the exposure on a single frame. Further-

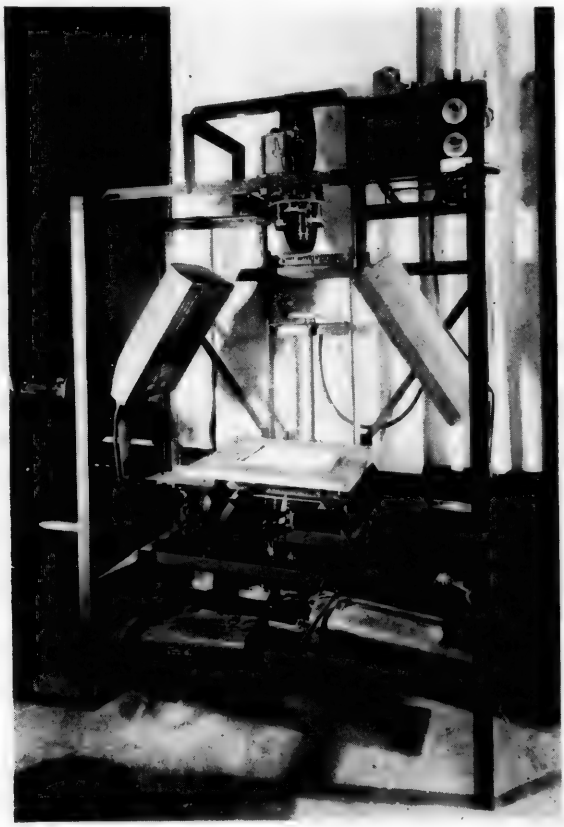

FIG. 13. APPARATUS CONSTRUCTED BY BELL AND HOWELL CO., USING A BELL AND HOWELL STUDIO CAMERA

more, the light on the control board burns while the shutter is open and this enables the operator to count the number of frames which pass through the camera at the time they are being exposed.

The rheostat shown in the lower right-hand corner of the control board may be used to determine the speed at which the film passes

through the camera. In this way the time of exposure may be controlled. Variations in the shutter angle of the camera and the diaphragm of the lens may also be employed to control the exposure. The trick lever on the camera may be engaged or released to permit one frame or eight frames to be exposed with each turn of the crank. The two-way switch shown in the upper right-hand corner of the control

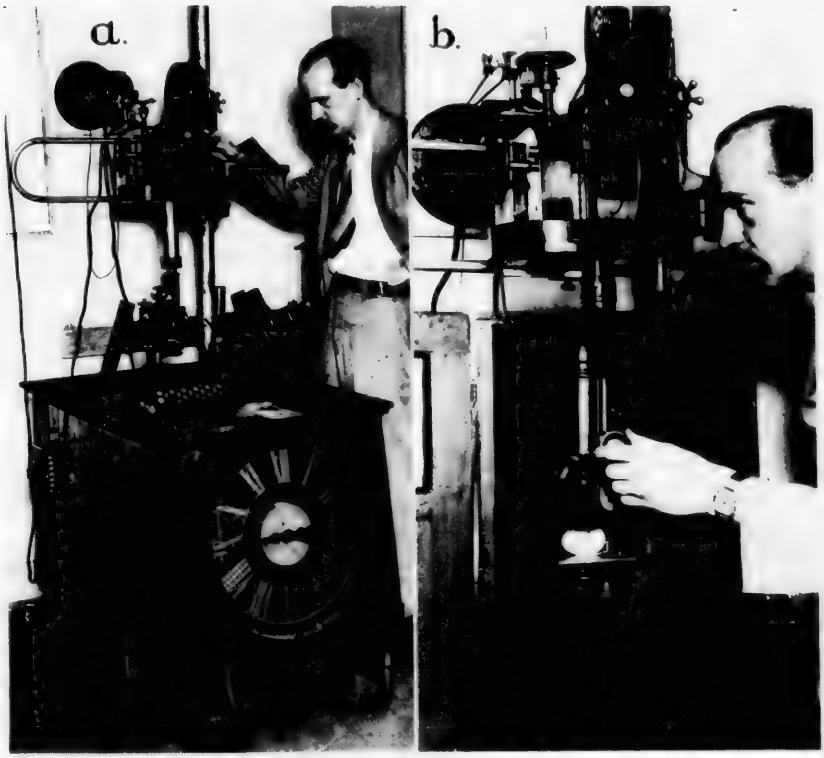


FIG. 14. AN APPARATUS CONSTRUCTED AT THE UNIVERSITY OF MARYLAND FOR DOING VARIOUS TYPES OF STOP MOTION WORK

board may be used to reverse the motor for driving the camera forward or backward.

Figure 14a shows a rather elaborate apparatus developed by the author for a large variety of work. The camera in this apparatus may be tilted at many angles and still operate automatically from the control unit. The mechanism may also be controlled by hand through an

electric switch for photographing titles and animated drawings. Many automatically controlled exposures varying from one frame per hour to thirty-two frames per second may be made. There is also incorporated within the unit a mercury relay for automatically turning on and off 2000-watts or less of light. Such lights may be plugged into the apparatus at convenient outlets. This lighting arrangement is suitable for making stop motion pictures of growing plants.

The apparatus shown in figure 14a is arranged for making continuous motion pictures through the microscope. Figure 14b shows the camera apparatus of this equipment mounted above an incubator within which is a microscope that is being used to make accelerated motion pictures of the development of the chick embryo. The taking of such pictures at intervals is entirely automatic. The light for these pictures comes from an outside source through a small window to the left in the incubator. Another source of transmitted light is beneath the microscope. The ribbon filament bulb and Point-O-Lite serve well for these purposes.

For a more complete description of advanced apparatus for the photography of animated drawings and other trick work the reader is referred to an article by J. A. Norling in The Journal of the Society of Motion Picture Engineers, Vol. XXVIII No. 2, February, 1937.

From such apparatus the artist and photographer should understand something of the mechanics of making and photographing animated drawings. If he has any mechanical ability he should be able to construct an equipment suitable to his purposes from the pictures herewith reproduced.

It seems evident that animated drawings will play an even greater part in the dissemination of scientific knowledge than they do at present. This is indeed a fascinating branch of medical illustration and will not only be interesting to the artist and photographer, but will tax his ingenuity and imagination in developing new processes and equipment.

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# SURGICAL MOTION PICTURES: EQUIPMENT AND TECHNIC*†

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*Rochester, Minn.*

As a result of the growing popularity of amateur movie cameras many persons are attempting the filming of surgical procedures. While such films are not difficult to produce, it is often desirable to prepare special apparatus in order to obtain the best results. The design of the equipment should be governed by the type of operation to be filmed and by the rooms in which the apparatus is to be used. The apparatus herein described has given satisfactory service for most types of operations and has been used in filming several hundred operations in the past five years.

## THE CAMERA

For surgical cinematography it is very important that the camera should be of a design that will permit critical focusing through the lenses. Several such cameras are on the market. Cameras without the built-in focuser can be used for some procedures if only short focus lenses are used and the distance is carefully measured. Instead of the 16 mm. camera one may use cameras of other sizes (8 mm., 9.5 mm., etc.), but in this article only the 16 mm. size camera and its lenses will be considered.

The number and type of lenses needed are dependent on the kind of work being done and the available working space. I use the following lenses: 15 mm. f:2.8, 1 inch f:1.9, 2 inch f:3.5, 3 inch f:4.5 and 4½ inch f:4.5. Working at a distance of 4½ to 8 feet from the surgical field the 1 inch, 2 inch and 4½ inch lenses have been most useful. The 3 inch

* From the Department on Photography, The Mayo Clinic.

† Submitted for publication April 22, 1937.

lens is used when the $4\frac{1}{2}$ inch lens gives too much magnification and when the 2 inch lens includes too much field. The 15 mm. (wide-angle) lens is sometimes needed when one desires to show the position of the patient on the operating table. It is also useful when making post-operative pictures in the ward.

Electrically driven cameras are a convenience but the spring drive is satisfactory for most work. The film capacity of the camera is generally an item of minor consequence; it is important that the cameraman should be familiar with the mechanism so that there will be no unnecessary delay when reloading.

## LIGHTING EQUIPMENT

The number of lighting units should be held at a minimum. I use only one lamp in addition to the light ordinarily used by the surgeon. The unit is a Solite lamp with concentrating lens to which have been added sliding arms for focusing the beam. It was found that a converging beam of light produced more pleasing results than did the parallel rays from a spotlight. The Solite lamp requires a 500 watt projection bulb and as it illuminates a rather small field it does not throw much heat on the operating team. When larger areas are to be brightly lighted a larger lamp (Halldorson) equipped with a 1,000 watt bulb is used.

Both of these lamps are very efficient and produce a field of light which is bright in the center and gradually decreases in intensity toward the periphery. This characteristic is useful in surgical filming as the dark incision receives more illumination than do the light colored drapes. Incidentally, it has not been found necessary to resort to the use of the dark colored drapes in avoiding glare.

## CAMERA MOUNTINGS

Surgical filming should not be attempted without a tripod or some other steady support for the camera. The tripods supplied for movie cameras are not designed for use on the smooth floor of the operating room. They can be fitted with rubber tips and antispreaders, but a more convenient arrangement consists of a centerpost tripod to which has been fitted a panoraming and tilting top as shown in figure 1. This unit can be carried in one hand and can be placed on a smooth floor without danger of slipping. It can be used between the benches in the visi-

tors' gallery and is useful in the crowded wards when taking postoperative pictures.

FIG. 1. One thousand watt tungsten lamp in reflector (Halldorson); tripod (Ley) fitted with panoraming and tilting head (Truball); the top section of the tripod is a length of heavy pipe which is used with the clamps shown in figures 2 and 3.

A more solid support is shown in figure 2. This consists of the same tripod head and post which is fitted with a clamp for fastening the unit

to the front of the visitors' balcony. A tightening lever permits locking of the camera at the desired height and angle. Immediately below this lever is a locking swivel joint which permits the camera and post to be swung from side to side in order to give improved perspective from certain angles. A simple clamp is provided for the lamp. This arrangement has proved very satisfactory and has been used during the production of most of the films at The Mayo Clinic.

FIG. 2. Camera (Eastman) and 500 watt lamp (Solite) mounted in visitor's gallery by means of special clamps; a locking lever holds camera at desired height and angle; tilting top aids in keeping lens centered on subject.

In figure 3 is shown a movable stand constructed for use in rooms that do not have a balcony. This is also employed when the camera is needed as close to the table as is safely possible. The stand is equipped with ballbearing casters for easy movement and with screw jacks which rigidly support it when in use. The frame is made of 1 inch steel pipe and is partly covered with an apron of sheet metal. The shelf is made of wood, as is the 22 × 26 inch platform which is 2 feet from the floor.

The camera and light are clamped to the 2 × 6 inch oak crosspiece which is 5 feet from the floor. Therefore the camera may be used as high as

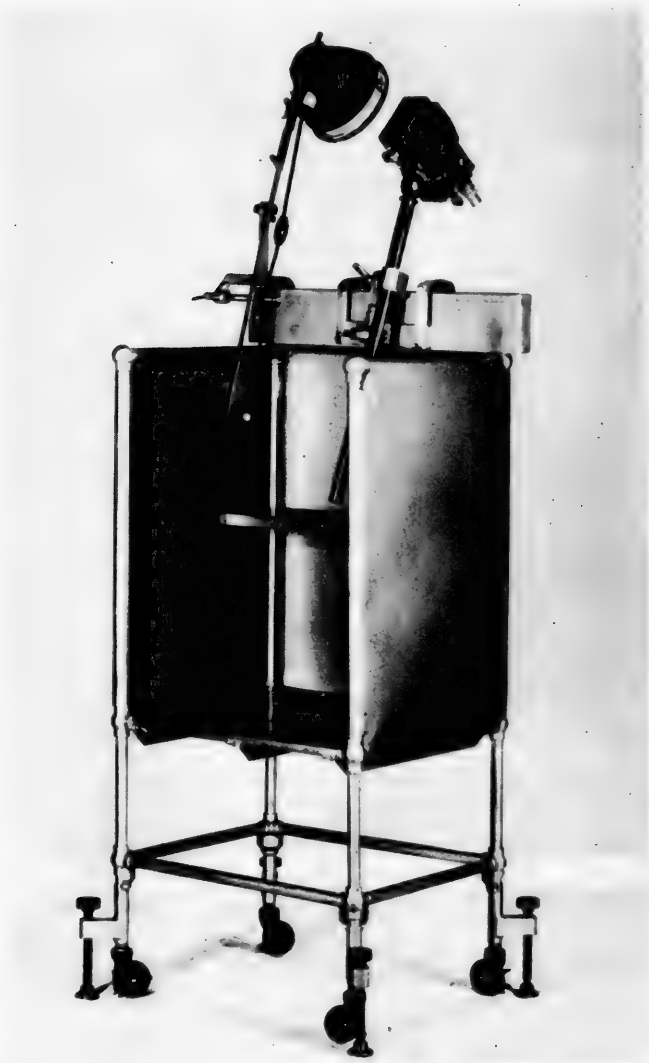

FIG. 3. Movable stand for supporting camera, light and photographer; when used near the operating table, it is draped with a sterile sheet.

8 feet from the floor and even at this height the unit is free from vibration.

## TECHNIC

When planning the film one should consider its purpose and the manner in which it is to be used. This will roughly indicate the amount of detail to be photographed. For example, if the film is to be presented before a surgical society it may show less routine detail than if it is to be used for the instruction of students in medical schools. A limited amount of program time will serve as a further guide in avoiding the waste of film. It is advisable that the surgeon and his assistants prepare in advance an outline of the steps to be filmed. While intent on his work the surgeon may occasionally overlook the presence of the cameraman, therefore if the surgical assistants are familiar with the scenario they can help in preventing the omission of desirable scenes. The operating team must remain aware of the camera angle and do its work without unduly obstructing the view for the lens. This will be easier after one film has been completed and carefully studied when shown on the screen.

Dramatic lighting effects should be avoided in the making of surgical films, as conspicuous shadows and backlighting are decidedly disturbing. I use only one lamp, which is placed as close to the camera as is convenient. This insures a well illuminated field and an absence of dark shadows. The overhead operating light is usually left burning so that the surgeon can see to operate even if there is any obstruction to the beam from the camera light. If the interval between scenes is rather long the camera light may be turned off.

Before the operation is begun the camera should be set up at the best angle. This may necessitate some moving or turning of the operating table, but usually the best camera angle is obtained by sighting over the right shoulder of the surgeon. The position of the patient on the table should be photographed before he is completely draped. The 1 inch or the 15 mm. lens will probably be better for filming this first scene. The incision is then filmed with the 2 inch lens and enough field should be included to readily orient the audience. As the operation progresses the cameraman must use his judgment in changing to telephoto lenses, but it should be noted that too much shifting produces a disturbing effect on the screen. The telephoto lenses are excellent for magnifying detail in a small field and should be used whenever possible. Near the completion of the operation the short focus lenses are again used and the closure of the skin is filmed with the lens which was used for photographing the incision.

The surgeon should instruct the cameraman when to start and stop filming a scene. The scenes should be long enough to look well on the screen and yet not terminate too abruptly, as there will be a slight loss of footage when the titles are spliced into the film.

Between scenes the photographer should wind the camera and check the focus. Using telephoto lenses at close range requires constant checking of focus and the small field must be kept centered as even a pull on a retractor may shift the field completely out of the picture. The film footage should be watched and the camera usually may be reloaded between scenes without delaying the operative procedure. The exposed reels should be numbered as an aid in assembling the developed films.

I use supersensitive panchromatic reversal film without a filter, at a taking speed of sixteen frames per second. For filming the incision the diaphragm aperture is usually about f:5.6 to f:6.3, and as darker tissues and deep cavities are encountered the exposure is increased. The 3 inch and $4\frac{1}{2}$ inch lenses are most often used at an aperture of f:4.5 to f:5.6. An exposure meter is helpful where the reading can be made sufficiently close to the field. If the lighting technic is standardized there will be little difficulty in estimating the exposure after the first film has been made and studied. A rather full exposure results in a film which shows up satisfactorily when projected on a large screen.

The same technic is used when making the color movies with Kodachrome Type "A" film. This film is very sensitive to variations in intensity of illumination and the exposure must be more exact. The latter presents a rather difficult problem in some of the older hospitals where private light plants are overloaded and a constant fluctuation of voltage results. When using this film all daylight should be excluded from the room as even a small amount may produce blue reflections on the instruments. The operative field must be closely watched and diaphragm adjustments should be made to compensate for differences between tissues of light color and those dark in tone.

## EDITING

Editing is a very important phase of film production and should not be slighted, although it requires more time than does the actual filming of the operation. When the films are returned from the processer the numbered reels are spliced and put on one reel. The film is projected and the surgeon views the entire reel at least once in order to note its general appearance. If any scenes are to be shortened or eliminated

the film is again projected and the machine stopped at the site of each cut, while the film is marked with a red wax crayon. A transverse line is used to indicate where the film is to be cut and a letter "O" is placed at each end of the strip which is to be eliminated. This method is quick and accurate and takes very little of the surgeon's time, as the cutting can be done later. If roentgenograms or drawings are to be used in the film, they should be photographed and spliced into their proper places. The surgeon again reviews the film and dictates titles. These should be typed in triplicate form as the original goes to the title maker, one copy remains with the film and one is kept in the surgeon's office. Before the titles are made, however, they are checked with the film. Each title is given a number on the carbon copy and this number is marked on the film where the title is to be inserted. It is then a simple matter to place the film titles at the proper place when they are completed. While projecting the film the editor may find that some of the titles remain on the screen too long and must be shortened. When the necessary alterations have been made the surgeon should review the film for final approval. On a file card is recorded pertinent data such as the patient's name and number, the dates of preoperative and postoperative pictures, the date of operation and the running time of the film. The leader strip and the film container are properly labeled. A good way to label the film can is to type on a strip of adhesive tape, after this is placed on the can it should be covered with several coats of clear, thick lacquer. Before the film is shown again it is well to have a duplicate made to be used while the original is safely filed away.

## SUMMARY

The equipment described is rather complete and has been used in filming a wide assortment of surgical procedures under varying conditions. Where the filming is limited to one type of operation it is possible to use a more simple camera and fewer lenses. It may be possible to photograph the subject with no extra lighting other than that already present in the operating room. The important thing is to have a steady support for the camera and to have the lens properly focused. After a test exposure has been made it should be possible to produce any number of satisfactory films provided the same lighting is used each time. While the technic can be simplified and standardized the best results will be produced when there is close coöperation between the surgeon and the cameraman.

# MINIATURE CAMERA PHOTOGRAPHY WITH THE HAND LENS*†

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*Pittsburgh, Pa.*

Many students of the natural sciences are engaged with material in which complete photographic records of specimens would be of value. The majority are forced to forego this advantage because of the expense involved. The objection with regard to the cost of the negative material has been largely obviated at the present time by the use of the miniature camera employing 35 mm. film. On the other hand, the initial cost of the camera in most instances and of the necessary accessories for the photography of small objects has kept the method beyond the reach of the scientist of ordinary means. While a large institution may be able to provide one of the higher priced miniature cameras for a number of workers, the small group or individual cannot do so. In many cases the extreme fidelity and latitude provided by the more expensive instrument is by no means necessary and may be entirely wasted. Frequently there is a demand for an adequate record at a reasonable cost rather than a perfect picture. The suggestion embodied in this article is intended to make such photographic records available at maximum speed and volume, and minimum cost.

There is now available an inexpensive miniature camera of the zone focusing type carrying an f:4.5 lens and selling for $12.50.‡ While modifying lenses are available which enable one to work with specimens of considerable size, there is no provision for the photography of small objects (0.5–5.0 cm.). We have, however, been able to adapt the camera to this type of work.

The photograph is taken directly through a hand lens of medium power, with the lens of the camera set in the infinity position. The mechanical parts for accomplishing this are extremely simple and may be made in a few hours in any small shop. The resulting completed instrument has proved in our hands to be sufficiently accurate and faithful in reproduction for all purposes of record and in the majority of instances the results are good enough for publication when required

* From the Institute of Pathology, The Western Pennsylvania Hospital.
† Received for publication May 5, 1937.
‡ Argus camera, International Research Corporation, Ann Arbor, Mich.

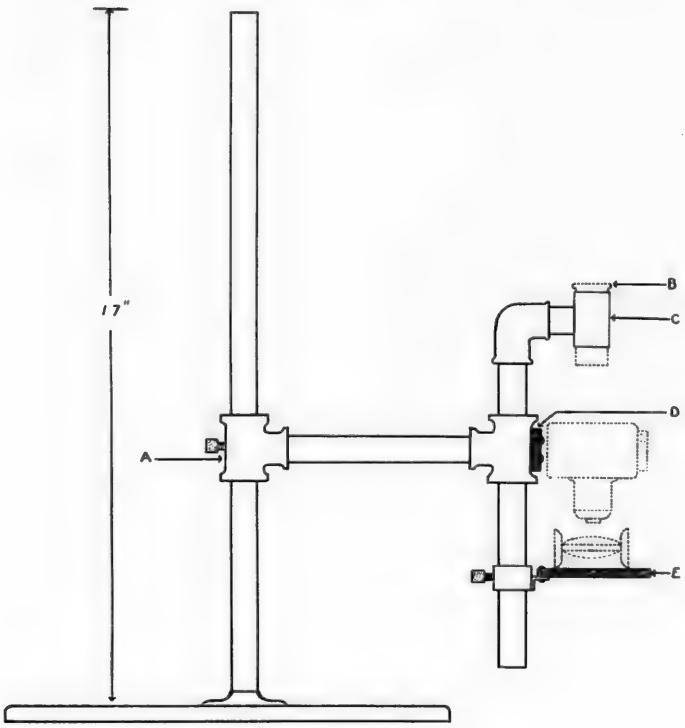


FIG. 1

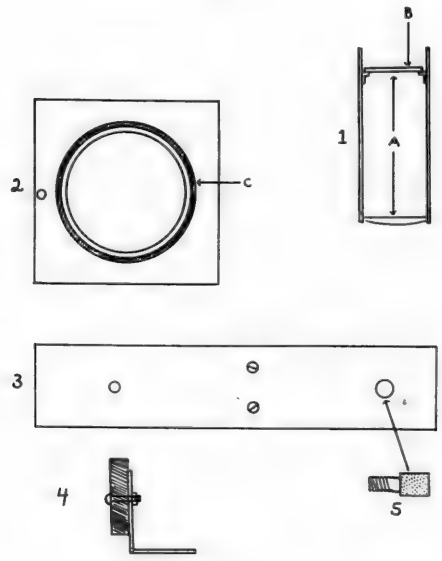


FIG. 2

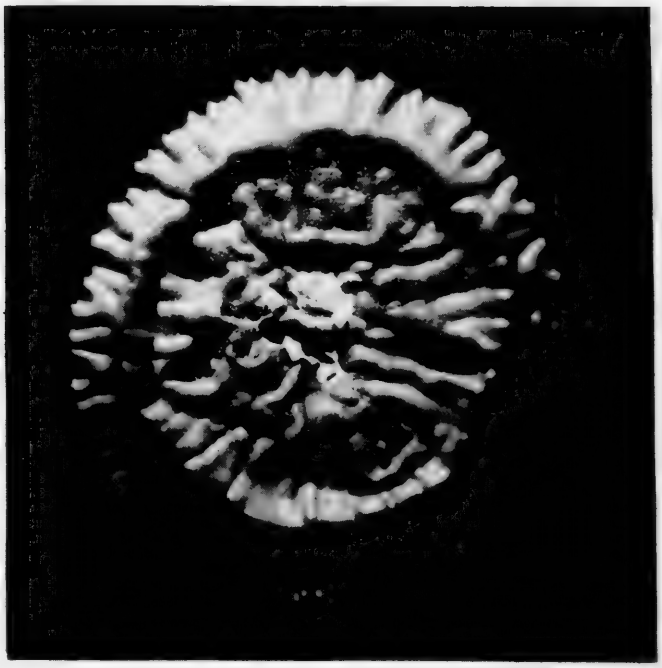

FIG. 3

FIG. 4

FIG. 3. Colony of *Actinomyces hominis* taken on positive film through hand lens. Original diameter 24 mm.

FIG. 4. Medium size moth taken through hand lens on panchromatic film. One half of the hand lens was removed to give a sufficiently large field. Original width 70 mm.

The initial investment is so low that each individual worker can afford to have a complete instrument always at hand and available for immediate use as desirable material presents itself. In our laboratory the work is primarily bacteriological and involves considerable study of bacterial colonies. The photographs of these colonies are incorporated directly into the laboratory notes in the form of contact prints, and such pictures as are desirable for publication may be readily enlarged later from the negatives which are kept on file.

The device is shown in figure 1. The base is that of an ordinary large size laboratory ring stand and the parts are largely standard three-eighth inch brass pipe and fittings. (A) is a standard "T" which has been bored out to give a sliding fit with the upright. This need not be extremely close. (D) is a strip of one-quarter inch Masonite shown in detail in figure 2 and serves for mounting the camera in position. (E) is similarly of one-quarter inch Masonite and is an adjustable table to hold and focus the hand lens. (C) is thin walled brass tubing of seven-eighth inch internal diameter, and is soldered to the side arm of brass pipe. It serves to hold the focusing device (B) which is shown in figure 2. The removable portions of the instrument are shown in dotted lines. The dimensions are purely arbitrary and may be varied according to the use to which the set is to be put. The overall dimension gives an approximate idea. The joint with the base flange should be soldered and the flange in turn bolted to the plate.

Figure 2 (1) shows the detail of the focusing device which is made by removing the top lens of an old 5× microscope ocular and substituting a ground glass (B) on a supporting ring. The distance A must be set by experiment. This is done by removing the back of the camera with the lens set at infinity and substituting a piece of ground glass in the film track. The camera is now placed in position and printed matter is brought into focus by adjusting the hand lens. The camera is removed and the focusing device placed in its mount. The ground glass may now be moved up and down in the tube until the sharpest focus is obtained. The setting should be rechecked two or three times and the glass finally cemented in position. This device is now adjusted so that all focusing may be done through it with the assurance that the camera will also be in focus. The distances from the hand lens to the camera or to the focusing device are, of course, not critical. The interchange of hand lenses does not affect the setting of the focusing device.

Figure 2 (2) shows the detail of the lens table. (C) is a groove to receive the rim of the lens. Figure 2 (3) is a detail of the camera mounting strip which is held to the "T" by bolts. (4) shows a supporting angle at the end to hold the camera in a horizontal position. The other end of the camera is held by a bolt (5) which fits the threaded socket of the camera.

In use the camera is removed from the mounting and the object is brought into focus on the glass of the focusing device by adjusting the height of the hand lens. The camera is inserted with the lens at infinity and well stopped down to give depth of focus, and the picture is taken. The depth obtained is much greater than when the low power objective of the microscope is employed. In the case of many objects which are similar, as in our work, it is not necessary to refocus for each separate photograph and a surprising number of pictures may be made in a brief period of time.

The hand lens which we employ (engraver's glass) is composed of two plano-convex lenses with a magnification of 3.5× and a working distance of 75 mm. This yields a magnification of 0.7× on the negative. When desired, one lens can be removed with a resulting increase in the size of the field and a decrease in the magnification. Needless to say, the lens should be chosen for the work in hand. The field as seen in the focusing device is much smaller than in the camera. It is not advisable to so adjust the system as to use more than the central two-thirds of the negative, as distortion will be apparent near the edges as a result of the lack of correction in the hand lens.

The negative material employed depends entirely upon the work to be done. We have been able to use positive film for most of our work with a resulting decrease in cost. For illumination we have employed an ordinary microscope lamp with a condensing system. This will again vary with the material portrayed.

The inexpensive character of the method and the great volume of satisfactory record pictures obtainable with it should be of interest in nearly all fields of biological science.

Since this article was prepared we have further modified the equipment by dividing the Masonite camera support strip between the points where it is fastened to the "T" and to the camera. The two parts are joined by a one inch brass hinge. This permits swinging the camera to one side instead of removing it entirely for focusing on new objects. As a result much greater speed can be attained.

# PHOTOGRAPHIC TECHNIC, NEW PROCESSES AND EQUIPMENT*†

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*Boston, Mass.*

## "ON THE APPLICATION OF PHOTOGRAPHY TO PRINTING." HARPER'S MAGAZINE, SEPTEMBER, 1856

The following extracts from the above-named article constitute one of the earliest references to photography applied to medicine and biology.

"The publication of Dr. John W. Draper's book on human physiology, "Human Physiology, Statical and Dynamical, or a treatise on the Conditions and Course of the Life of Man," presents several circumstances of general interest.

For the first time the attempt has been made, on an extensive scale, to illustrate a book on exact science by the aid of photography. It is, of course, admitted on all hands, that no matter how excellent drawings may be, they can never approach in reliability to photographic delineations; and this not only as respects objects which, from their scientific uses, derive their value from the precision with which they have been depicted, but equally so as respects those of general art. We look with a very different eye on the representation of some architectural subject, or even landscape, when it has been sketched by the painter, or taken by the photographer. In the latter case we examine every detail minutely, which presents an indescribable charm to us, because we know that mere imagination has had nothing to do with its presence, but that it is there because it is a fac-simile, a truth.

Photography had scarcely been invented when repeated attempts were made to secure these great advantages for typography. Mr. Fox Talbot, who was one of the earliest cultivators of that art, devoted his attention to this subject; and the same has been done more or less extensively by various other persons. In these instances the object was photographically printed, and not retouched by the artist. As an example of this kind of work, we may mention the New York "Photographic and Fine Arts Journal," edited by Mr. Snelling, and which from time to time has contained specimens of very great excellence, executed by our most skillfull photographers.

This plan, in which the illustration presented to the reader is an absolute photograph, made, so to speak, without human agency, and by the sunlight alone, leaves, of course, nothing to be desired. Unfortunately the present condition of photography is such, that it is only in a few instances we can avail ourselves of these advantages. A book to be illustrated with three hundred of such drawings—a number by no means unusual, and of which it is necessary to publish an edition of five thousand copies—would require 1,500,000 of separate photographs to be made. And no matter what might be the devices resorted to for

* From the Department of Photography, Children's Hospital.

† Received for publication August 6, 1937.

shortening the labor—such as by printing from several originals at the same time—it may be safely asserted that the operation would be wholly impractical in any reasonable length of time.

Since thus, in the present state of photography, books cannot be illustrated by absolute photographs, on anything of an extensive scale, attempts have been made to obtain aid from some of the older typographic arts—as, for example, by causing the sunlight to yield etchings on copper or steel, and then to print from these plates in the ordinary way. But though some of the ablest artists and photographers have exerted themselves in this direction, no really practical result has thus far been attained.

So therefore, since we cannot reach even this degree of excellence, we must descend a step lower. We must prepare the best photographs we may, and transferring them by the hand of the artist to the surface of wood, or stone, or metal, rely upon him to produce therefrom fac-simile engravings. To be sure this is but a very moderate degree of success, since human agency or human skill have a little too much to do with the result; nevertheless, the reader will find that the advantages at once accruing are very great. It is in this manner that Dr. Draper's book has been illustrated, and we propose to draw from it some proofs of the assertion we have just made.

Works of exact science derive their value from the accuracy of their minute detail; and this is more particularly the case with those on anatomy, physiology, and the sciences of organization generally. Very often the most important doctrines turn on the ascertaining of the structure of objects invisible to the naked eye. For this purpose, microscopes must be resorted to, of which those only can be relied upon that are of the most modern construction, and of very great cost. A first class microscope is worth about a thousand dollars, and even at that price is obtained with great difficulty. It requires, moreover, considerable skill in its use; and so many are the optical deceptions, and so great the difficulty in coming to precise conclusions, where the observers cannot look simultaneously at the object, and contrast their opinions, but one has to see it after another, that the most remarkable discrepancies are continually arising.

Now if highly magnified microscopic objects could be taken in all their sharpness on a photographic surface, these difficulties and discrepancies would be at an end. Indeed it may be truly said that the invention of a method accomplishing this would actually lead to a revolution in the sciences mentioned. Accordingly, attempts have been made, again and again, both in America and Europe, at effecting this object, but not with the wished for success, until about three years ago, when Dr. Draper completely solved the problem, by a process not hitherto published, but which he has extensively used in the illustration of his book."

The article quoted from contains some twenty illustrations or more, both gross and microscopic subjects being represented.

### NEW MATERIAL TO KEEP CULTURE MATERIAL FROM DRYING OUT

A new product called "Parafilm" is being marketed by the Menasha Products Company. The purpose of this material is to keep culture media from drying out

either at room temperature or incubator temperature. It is being used particularly for Loeffler's medium, blood agar slants and blood agar plates. For this purpose and for preservation of stock cultures Parafilm works well. A square of this film pressed down on the mouth of a culture tube, the cotton plug having first been pushed in, keeps the slant from drying out for weeks. It is equally efficient in keeping the volume of a broth tube or flask unchanged. The advantage over paraffin or wax is that the seal is readily stripped off and the cotton plug remains perfectly manageable. The address of the company manufacturing this material is The Menasha Products Co., Menasha, Wisconsin.

# Association News

## 1937 CONVENTION

The Convention of the Biological Photographic Association will open its doors, September 23, 1937, at the Hotel Rochester, Rochester, N. Y. A three-day meeting packed with interesting papers, discussions and exhibits has been planned. Every minute will be taken up with the discussion of photographic problems. Photography in medicine, surgery, natural history, research and allied fields will be treated and discussed by authorities.

Do not hesitate to come to this meeting. Nowhere during the year can you obtain an educational photographic course such as this meeting will present and which will be so pertinent to your needs. The beginner and advanced photographer both will gain firsthand information of definite value to their work. This convention provides an opportunity to meet and talk with photographic workers well versed in scientific photography.

The following program has been arranged by the Chairman of the Program Committee, Mr. William Payne, State Institute for Study of Malignant Disease, 113 High Street, Buffalo, N. Y.

Motion Pictures (16 mm.) of Tissue Cultures (Ciliated Epithelium). Dr. Arthur Proetz, St. Louis, Mo.

Photomacrography. Mr. Louis Schmidt, Rockefeller Institute for Medical Research, New York City.

An Illuminating System for Large Transparent Sections in Photomicrography. Mr. J. V. Butterfield, Scientific Bureau, Bausch & Lomb Optical Co., Rochester, N. Y.

The Use of Polarized Light in Photography. Mr. J. W. McFarlane, Rochester, N. Y.

Infra-red Photography. Mr. Leo C. Massopust, Marquette University School of Medicine, Milwaukee, Wis.

Phantom Photographs. Mr. F. R. Harding, The Children's Hospital, Boston, Mass.

Colored Light, Filters and Photography. Dr. Oscar W. Richards, Spencer Lens Company, Buffalo, N. Y.

Importance of Photography in Crime Detection. Lt. E. F. Burke, Rochester, N. Y.

Photography in Criminology. Mr. Louis Waters, Syracuse, N. Y.

Medical Motion Pictures (16 mm.) in Kodachrome. Mr. Harris B. Tuttle, Rochester, N. Y.

Eye Photography. Mr. F. W. Jobe, Rochester, N. Y.

Demonstration of Portrait Lighting. Mr. Harry Wills, Rochester, N. Y.

Chromotone Process of Color Photography. Mr. Roland S. Potter, Vice President, Defender Photo Supply Co., Rochester, N. Y.

Experiences in the Preparation of Illustrations for Publications. Mr. Natt Jacobs and Mr. M. C. Orser, University of Rochester School of Medicine, Rochester, N. Y.

Theory and Demonstration of Color Photography. Members of Eastman Kodak Company, Rochester, N. Y.

Other papers are in process of preparation.

Dr. C. E. Kenneth Mees, international authority on photography, will be the guest speaker at the banquet to be held Friday evening, September 24. Dr. Mees is a brilliant scientist and speaker. He was recently awarded the Henry Draper Medal by the National Academy of Sciences in Washington, D. C., in recognition of his investigations in photographic processes which have given emulsions sensitive to the red and infra-red of the spectrum and made possible the recent great advance in knowledge of this highly important region of the radiant energy of the stars.

One of the features of the program will be a motion picture symposium covering subjects of special medical and biological interest.

An exhibition of prints depicting various aspects of medical and biological photography has been arranged by the Chairman of the Salon Committee, Mr. Leo C. Massopust, Marquette University, School of Medicine, 561 North 15th St., Milwaukee, Wis.

All nonmembers who are interested in the aims of this Association are cordially invited to attend this session and to learn the manner in which they can become a valuable part thereof.

* * *

After a tryout season of four meetings the Pittsburgh Chapter has voted to meet every month next winter. The plan is to alternate informal discussion meetings with more formal programs. At the May meeting the following officers were elected: *Chairman*, Mr. Chester O. Henry, Falk Clinic; *Vice-Chariman*, Mr. Graham Netting, Carnegie Museum; *Secretary-Treasurer*, Miss Anne Shiras, Department of Medicine, University of Pittsburgh.

* * *

Mr. E. P. Little, 156 Woodland Street, Worcester, Mass., is now X-ray technician at the Marine Biological Laboratory, Woods Hole, Mass. He is engaged in grenz-ray radiography of biological material.

* * *

One of our members, Dr. Charles Schroeder, who was formerly with the Zoological Hospital, San Diego, Calif., is now at the New York Zoological Park.

* * *

Dr. Jane Oppenheimer who has been working in the Osborn Zoological Laboratory, Yale University, will be situated at the Department of Zoology, University of Rochester, Rochester, N. Y., after October 1, 1937.

* * *

From the *New Yorker* of June 19, 1937, comes this timely poem by James L. Duff:

"As a matter of fact—"

"When a camera was a kodak
With no special shutter speed,
When a universal focus
Was all that one would need,
When 'Life' was being published
For people who could read,
We used to snap Aunt Emma
In her gown of lace and net.
We used to snap Aunt Emma
Not in some de-luxe dilemma;
No, we merely took Aunt Emma—
And we'd wait till she got set.

"Then no one with a Leica
Was behind the bathroom door;
Then no one with a Contax
Was snooping for your snore;
Folk took their pictures standing
And never from the floor.
In those snaps we took of Uncle,
We tried to hide the wen;
The finest snaps of Uncle
Did not show that old carbuncle,
And the chances are that Uncle
Would sit for us again.

"No Retina was peeking
Through the trellis and the trees;
No Graflex by the window
Caught Sis in her chemise;
No Argus at the picnic
Saw Dad's colossal sneeze,
When we took some shots of Mother
In the garden with a rose,
She was right side up, was Mother
You could tell it was no other
For we made the shots of Mother
And not of Mother's hose."

* * *

A large number of members are engaged in botanical photography and a few words concerning their activities are opportune.

Dr. L. W. R. Jackson of the Botanical Laboratory, University of Pennsylvania, Philadelphia, Pa., is building a collection of 2″ projection slides of fungi that cause diseases of forest trees. He is also collecting 8″ x 10″ as enlargements of diseases of forest trees.

Dr. Eloise Gerry, U. S. Forest Products Laboratory, Madison, Wisconsin, is making and collecting a series of photomicrographs of wood.

It is of interest to know that one of the largest collections of wild flower pictures is owned by our member, Mr. P. L. Ricker, President of the Wild Flower Preservation Society, Inc., Washington, D. C. Mr. Ricker also makes 16 mm. motion picture studies of flowers in monochrome and natural color, and 35 mm. lapse-time pictures.

Professor Paul J. Sedgwick, Syracuse University, Syracuse, N. Y., is employing time-lapse motion pictures, lantern slides, color plates and photomicrographs in teaching botany.

Mr. Russell Lee Walp, instructor of biology at Marietta College, Marietta, Ohio, is now using motion pictures of flowers and stills of shrubs and flowers for his class work.

Although Mr. Ralph Schopp is connected with the Bureau of Entomology in Puyallup, Washington, and so is primarily interested in insects, his work also includes photographic studies of plant injuries.

Mr. E. K. Walrath of the Eastern States Farmers' Exchange, Springfield, Mass. specializes in photography of plant nutritional deficiency symptoms, in monochrome and color.

As head of the Illustration Division of the Boyce-Thompson Institute for Plant Research, Yonkers, N. Y., Mr. L. P. Flory's photography covers many phases of plant growth and pathology.

Professor Walter E. Rogers of Lawrence College, Appleton, Wisconsin, incorporated his beautiful collection of enlargements of tree blossoms into a book called "Tree Flowers," well-known to every collector of tree books.

Mr. M. G. Schneckenburger, East Aurora, N. Y., is engaged in photography of flowers.

Mr. Julian A. Carlisle, Rockefeller Institute for Medical Research, Princeton, N. J., is engaged in photography of botanical subjects of interest to medicine.

* * *

We welcome the following new members to the Association and hope that they will attend our September meeting. We are sure that they will find an opportunity to discuss many things with other members interested in their particular specialty.

H. Burnett Armstrong, 1299 Lombard Street, San Francisco, Calif.
Lester V. Bergman, 2029—86th Street, Brooklyn, N. Y.
Kenneth W. Breeze, 681 West 169th St., New York, N. Y.
G. M. Busanovich, Germantown Dispensary & Hospital, Philadelphia, Pa.
Harlan Harrison, 84-14—53rd St., Elmhurst, Long Island, N. Y.
Fred Krome, St. Francis Hospital, Pittsburgh, Pa.
Daniel B. Lane, Photo Studio B-4, Eloise, Mich.
Herman de Las Casas, M.D., Oeste 2, #21, Caracas, Venezuela.
M. A. Obrenski, M.D., 904 West Genesee Street, Syracuse, N. Y.
Paul J. Sedgwick, Dept. of Botany, Syracuse University, Syracuse, N. Y.
Lawrence E. Shinn, Ph.D., West Penn Hospital, Pittsburgh, Pa.
Ray G. Wenger, M.D., 501 Douglas Avenue, Salt Lake City, Utah.
Charles S. Foster, 187 Wendhurst Drive, Rochester, N. Y.
William L. Lehle, Lehle Film Laboratories, 514 Park Avenue, Wilmette, Ill.

"Education throughout the United States is going 'movie' so steadily that at the present time audio-visual education is employed in 8,806 school systems in the 48 states, officials of the University of California report. California, with a school population of 1,551,510, possesses and uses 849 motion picture projectors. It ranks as the third highest in the union in this respect. New York is first, with a school population of 1,885,207, and 1,298 projectors. Pennsylvania is the second ranking state with 958 projectors for a school population of 1,498,606.

"As for educational films in the new system, Pennsylvania leads with 8,864, and New York comes next with 5,846 films. California ranks third with more than 5,000 films, while the University of California itself has a library of more than 5,000 pictures that are available to schools in the state." *Motion Picture Herald*, v. 128, p. 12, July 3, 1937.

* * *

"A new rule in the photographic contest running each month in 'Hunting & Fishing' magazine requires prize winners and hornorable mention winners to submit the name of the camera used, kind of film, aperture of lens and shutter speed, etc. It is believed that this information will add still more interest to the contest." *American Photography*, v. 31, p. 603, August, 1937.

ARTHUR W. FUCHS,
*343 State Street*
*Rochester, N. Y.*

# PLAN NOW

*To go to the*

# CONVENTION

OF THE

# BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

**Hotel Rochester**

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**Rochester, N. Y. Sept. 23, 24, 25, 1937**

***See Association News for details***

VOLUME VI *December, 1937* NUMBER 2

The Journal of the
Biological Photographic
Association

# PHOTOMACROGRAPHY*†‡

## (Enlarged Photography without the Use of a Compound Microscope)

LOUIS SCHMIDT

*New York, N. Y.*

*"The photography of large sections or similar transparent objects by transmitted light is, in some respects, the most difficult branch of photomicrography."*—J. E. Barnard (1).

Photomacrography includes magnifications up to about 50 diameters. The requirements are a wide barreled microscope and illuminating unit with a concentrated light source and a condensing lens, and a camera with lenses of proper focal length. Instead of the microscope the lenses may be placed on the camera lens board, in which case a rack and pinion focusing device are almost a necessity (plate 1, figs. 1 and 2).

As a substitute for the microscope stage a transilluminating device may be used which serves as a support for the specimen as well as a light source (plate 1, fig. 3). The lenses bear the names assumed by the various optical firms to designate their products, viz.: Micro-Planar, Tessar, Sumar, Luminar, etc. Their apertures are from f: 3.5 to f: 4.5. They

* From the Illustration Division, The Rockefeller Institute for Medical Research.

† Read at the 1937 Convention of the Biological Photographic Association.

‡ "Photomicrography, the art of obtaining photographs of microscopic objects on a magnified scale." A New English Dictionary on Historical Principles. Oxford, 1909.

usually have iris diaphragms and range in focal length from 16 mm. to 100 mm. The smaller sizes screw into the nose piece of any microscope; the 75 mm. and 100 mm. sizes and those of similar focal lengths may only be attached by means of special devices, such as the Zeiss funnel. This funnel screws into the upper part of the large barreled microscope from which the ocular and objective carrier plates have been removed (plate 1, fig. 2).

These lenses may all be used on the camera by means of lens boards. The iris diaphragm may be liberally used if the subject is opaque and the light is reflected, but very sparingly with transmitted light (plate 1, figs. 1 and 5).

As substitutes, motion picture lenses of 2-inch, 3-inch and 4-inch focus may be used to replace the low power lenses of 50 mm., 75 mm. and 100 mm. previously mentioned. They will give magnifications from 3 to 16 diameters with moderate bellows extensions.

Achromatic objectives of from 16 to 24 mm. may be used (without oculars) to give magnification from 16 to 40 diameters. Care must be exercised to prevent the projection of reflections from the inner surface of the ocular tube. A $1\frac{1}{2}$ inch strip of black matte paper inserted in place of the ocular will serve this purpose. With these lenses very careful adjustment of the light by means of the substage condenser is essential.

When the author uses the microscope stage with a mirror to hold the preparation, his illuminant is a 100 c.p. Point-o-lite (English Ediswan bulb) in a Bausch and Lomb lamp house with their aspheric condenser and iris. It is mounted on a rider and is adjustable for distance, height and angle (plate 1, fig. 2).

For softer lighting of cultures in dishes a frosted bulb is used in a matte reflecting hood mounted on a flexible stand. This is placed near the lens board with the light directed downward. A ground glass placed between the light and the object will increase the softness (plate 1, fig. 4).

For use on our perpendicular camera equipped with an Eastman 5″ x 7″ back with ground glass, a reflecting focusing hood has been designed and built. This rests on the outer frame of the camera back. The plateholder may be inserted without removing the reflector from the camera. This device, with its 45 degree mirror, provides the convenience of a Graflex in viewing the image on the ground glass almost to

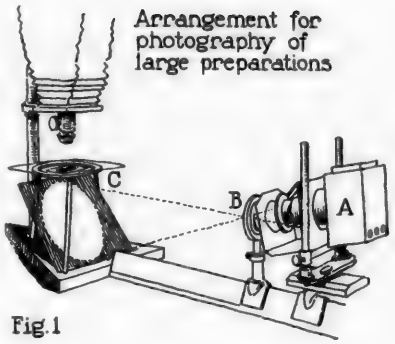


Fig.1

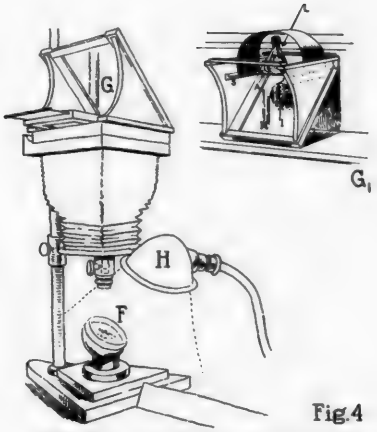


Fig.4
Cultures on opaque medium on tilted stage – diffuse light

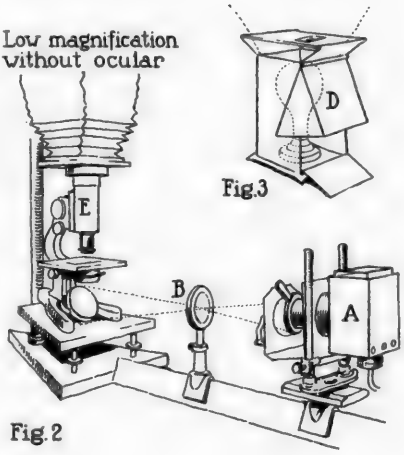


Fig.3

Fig.2

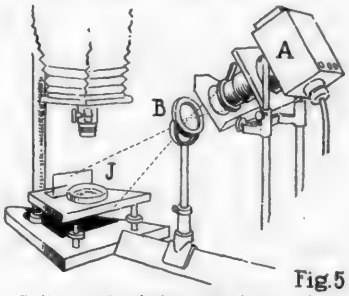


Fig.5
Cultures in dishes to show colonies in high relief – concentrated light

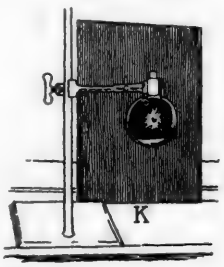


Fig.6

A-Point O Lite lamp with aspheric condenser.
B-Supplementary double convex lens.
C-Tripod and reflector for large specimens, 2x-5x
D-Substitute illuminating device-pulpit light.
E-Microscope with low power lens, 5x-50x.
F-Tilting and revolving stage for cultures in opaque media.
G-Reflex focusing device. $G_1$-Inverted to demonstrate cultures in liquid media on bottom of the flask.
H-Incandescent flood light in flexible mount.
J-Petri dish culture and reflector.
K-Arrangement for back-lighting translucent subjects.

PLATE 1

the instant of exposure. It is posible to observe the quality and distribution of the light, and placement and focus of the image while the hands are free to manipulate the specimen, adjust the illumination and focus the subject. This is a great convenience with all types of photography but practically indispensable when the subject is a living mouse or frog, even if it is anesthetized (plate 2, fig. 11). It may also be used to photograph cultures in liquid media by reflection, either on the bottom of flasks or in suspension (plate 2, fig. 12 shows the result). The illustration shows the arrangement (2) (plate 1, fig. 4, *G* and $G_1$).

Blueprints of the device may be obtained from the author (2).

Mr. Philip O. Gravelle, one of the members of this Association, has designed a camera back that serves the same purpose (3), as have several Europeans.

An arrangement for using a reflecting camera over a box-like extension, the Van Heusck vertical camera, is available in commerce, but is limited by the fixed bellows length (1).

### OPAQUE OBJECTS WITH REFLECTED LIGHT

The soft and pliable nature of some specimens and the importance of arranging others in preservative fluid make it necessary to use a horizontal stage. Therefore, a perpendicular camera is most convenient. Embryos and the organs of small animals and similar fresh materials are placed in liquid, in glass dishes of varying depth and size. If it is desired to show the general form with well-rounded modeling, use a shallow dish that will hold only enough liquid to cover the specimen. The light should be placed high enough to give the desired form. The author prefers to place the object in such a manner that the light will seem to come from above and the left. The shadows will then fall below and to the right as they would if the part were in the body, considering the head as the top. This appears to be the natural pose and the preferable lighting, except when the above treatment fails to show the main points which are

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PLATE 2

FIG. 7. Bovine tubercle culture. 4×
FIG. 8. Avian tubercle culture. 12×.
FIG. 9. Crystallized serum. 20×.
FIG. 10. Mixed crystals. 25×.
FIG. 11. Injected ear of mouse. 10×.
FIG. 12. Culture in liquid. 40×.

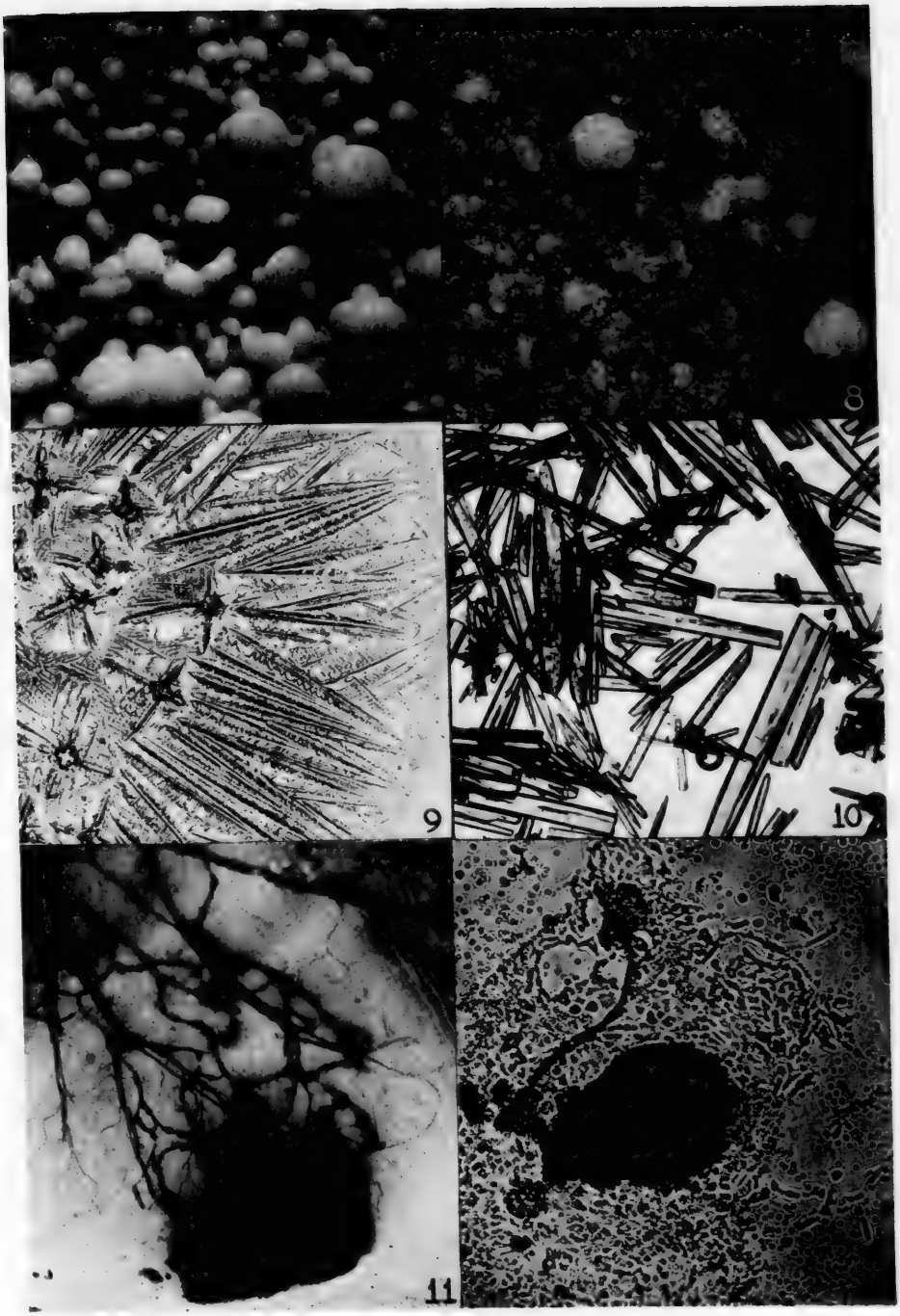


PLATE 2

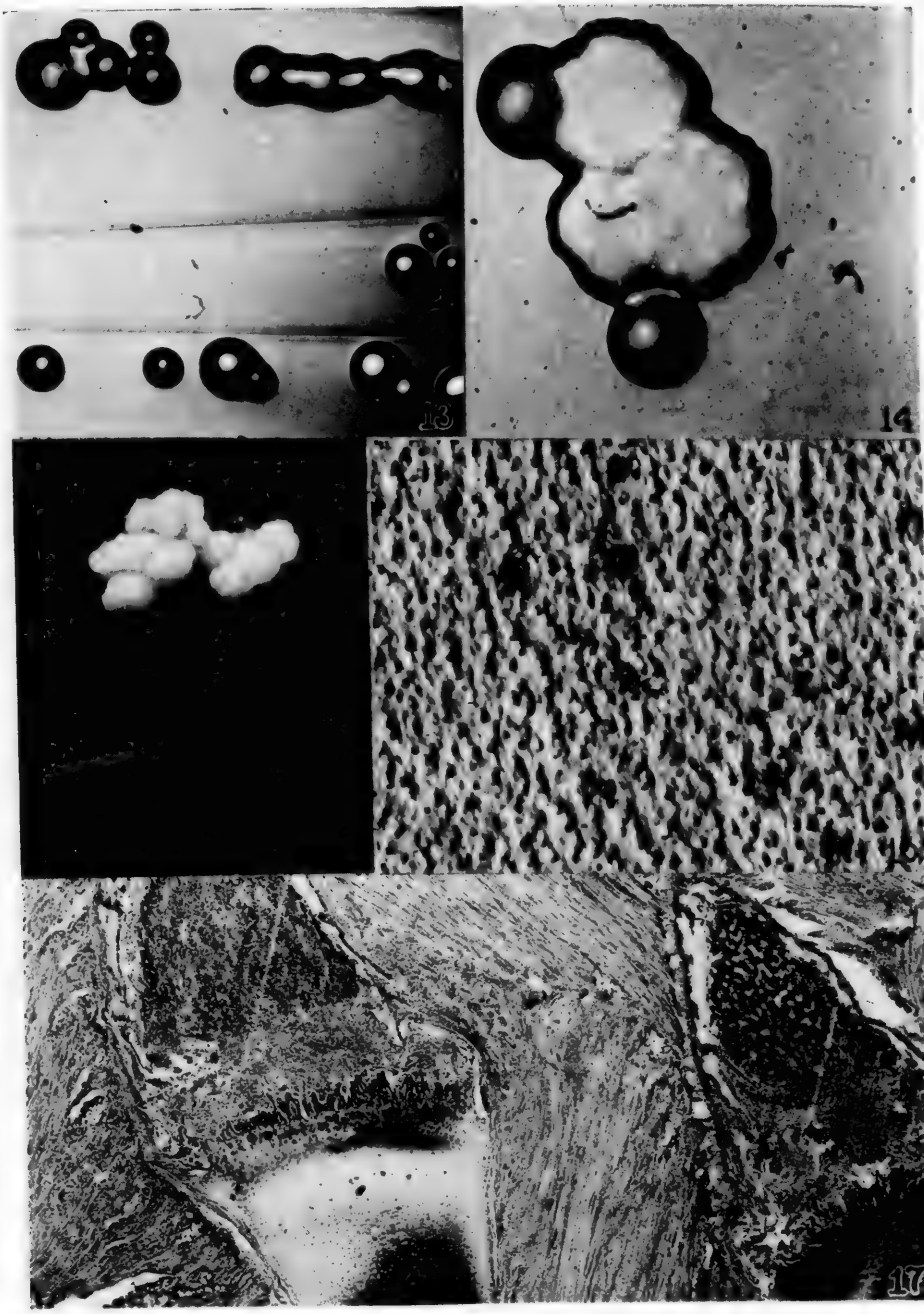


PLATE 3

to be illustrated. As the light unit is fixed the lighting is controlled by rotating the preparation or the dish in which it rests (2) (plate 1, fig. 5; plate 2, figs. 7 and 8).

If the shadows are too broad, the light should be raised; if they are too dark, a white cardboard reflector is placed near the object, or a supplementary light may be used on the unlighted side. Sometimes it is well to diffuse the light with a sheet of ground or flashed glass.

If the principal object of the picture is to show surface roughness, granularity or wrinkles, place the specimen in a deep dish with only enough liquid to cover it. Lower the light so as to cross-light the subject by projecting the light almost horizontally. In the case of wrinkles or folds, the illuminations should be placed at right angle to them as far as possible. Since the dish is high no shadows or reflections of its rim will fall on the preparation. Again the cardboard reflector may be helpful and if very sharp surface detail is desired the illuminant may be a spotlight.

In the photography of large, fresh or wet specimens the author does not place these in liquid, as a different technique has been developed. However, embryos and small organs must be kept moist with preservative solution in order to avoid post mortem deterioration (2).

A specimen may be most easily immobilized if it is placed in just enough liquid to cover it and no more. In order to avoid spilling the liquid is added or removed by means of a pipette.

If the specimen is buoyant as for example, a small lung, it may be placed in a dish, then completely filled with liquid and covered with a sheet of plane glass. All air bells should be excluded and a piece of cardboard of the proper shade may be placed under the dish to serve as a background. The stage must be level.

Objects such as gallstones, calculi, etc. may be placed on a sheet of glass, supported on corks or blocks, several inches above the stage. For a background cardboard of a suitable tone is slipped under the corks.

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PLATE 3

FIGS. 13 AND 14. Cultures in petri dishes on tilted stage. Diffuse top illumination. 8× and 12×.

FIG. 15. Lymph node. Concentrated light placed low to produce long shadows. 7½×.

FIG. 16. Leather. Oblique illumination. 18×.

FIG. 17. Muscle, cartilage and bone, stained. Transmitted light. 9½×.

In this way no shadows will appear in the picture. The glass should be large enough to conceal the corks or blocks in the photograph. However, the presence of cast shadows is frequently desirable to add height to the subject. These shadows may be shortened or lengthened by raising or lowering the light unit, in which case the background should be opaque (plate 3, fig. 15).

Cultures in petri dishes may be treated in the same way. If the cultures are not valuable the covers should be removed in the interest of good photography, as the covers are often optically very faulty and scratched (plate 1, fig. 5). Where contamination is to be avoided it is necessary to obtain the best results possible through the glass covers. The iris diaphragm should be closed only enough to give the depth of focus needed to produce a sharp image of the specimen, but not enough to bring its image into the picture. If the cultures are sealed with rubber bands the droplets of moisture which have condensed on the cover must be absorbed. This may be done by heating the dish slightly with a small spirit lamp just before the plate is exposed. The same procedure also applies to the photography of tissue culture flasks.

When such culture flasks are to be only slightly enlarged in order to show the entire flask or about half the flask, they are held in a perpendicular position. The neck of the flask is held in a chemical clamp which is fastened to an upright rod on an iron base (plate 1, fig. 6). This is placed on a window sill or a stand near a window, with the preparation about 6 inches above the base. Against the window and behind the flask is placed a sheet of black cardboard about 14 inches high by 10 inches wide. All the light should come from behind the preparation, over and around the background, with no front lighting. The camera must be level, the lens the height of the culture.

Cultures growing on blood agar medium, when studied in the laboratory on tilting stages, appear with a mirror-like background. The colonies are in sharp relief with very dark edges and strong shadows. They show a very clear distinction between rough and smooth varieties. The photograph should illustrate the same characteristics as the laboratory demonstration (4). As the stage holds the culture at an angle to the lens it is possible to show only a relatively narrow band in focus. The iris of the lens should be closed to widen this area of sharp definition (plate 1, fig. 4 and plate 3, figs. 13 and 14).

These directions for illuminating the subject should not be followed literally. In order to avoid brilliant high lights when the preparation is not in fluid, the quality of the light and the degree of its diffusion will control the character of the resulting picture. Other factors are the direction of the light and its distance from the subject, also the position and size of the reflector, or the supplementary light, for partially lightening the shadows. Only by careful study of all the parts that enter into the setup can first-class results be secured. Every subject presents problems that require individual treatment.

### STAINED AND MOUNTED SECTIONS WITH TRANSMITTED LIGHT

Sections of parts of the brain or other organs magnified less than 5 diameters require a stage capable of wide illumination. A chemical ring tripod covered with glass will serve. Use a sheet of white cardboard under the glass placed at a 45 degree angle as a reflector. The condenser of the light unit is so focused that it delivers a broad circle of light on the cardboard reflector.

To improve the quality and evenness of this light circle a double convex supplementary lens is placed in the light-path at the focal point of the illuminating system. The 75 mm. or 100 mm. lens is used on the upright camera (plate 1, fig. 1).

All the components of this setup must be so placed that the entire specimen is evenly lighted. This depends on the distance of the light unit and the focus of its condenser, the location of the reflector and the position and angle of the supplementary lens. Before exposing the plate, cover those parts of the preparation that are not to be included in the picture with black paper in order to eliminate glare and to improve definition.

Smaller sections requiring magnifications up to 50 are placed on the horizontal microscope stage and the light is projected by a mirror and a substage condenser. These magnifications require lenses of varying focal lengths, and the field of illumination should in every case be slightly larger than the area that is to be photographed. The intensity of the light should vary in proportion to the amplification and must be of uniform quality to the edge of the field. Zeiss has provided 3 simple substage condensers for use with its 5 lenses. They are the 1–2–3 spectacle lenses. Number 1 is used for the 20 mm., number 2 for the

35 mm. and 50 mm., and number 3 for the 75 mm. and 100 mm. Planars and Tessars. Other manufacturers have made similar provisions. Such condensers are not expensive and very useful.[1]

The lens is placed on the nosepiece of the microscope or on the front board of the camera with the rack and pinion focusing device. The correct spectacle condenser is placed in the substage and the mirror is put in its place (plate 1, fig. 2).

The light unit should be focused by means of its condenser and the supplementary lens, if any, so that the mirror is completely filled with light. Project this by the use of the substage condenser in order that the part of the specimen that is to appear in the picture, and a little more, is evenly illuminated. This is accomplished by raising or lowering the condenser and carefully centering the light by means of the mirror.

The mirror is hung by two screws to the ends of a crescent-shaped frame, which is attached by a plug at its center to a sliding bearing in which the plug rotates. The mirror should swing freely on its screws and the plug must rotate smoothly in its bearing. Use the plane side of the mirror.

Accurate centering of the light is indispensable. The author tilts the mirror, on the axis of the screws, several times toward and from the light source. The circle of light is seen passing across the focusing screen until the circle is centered in that direction. Then, without disturbing this arrangement and holding only one of the screws of the mirror frame, the mirror is rocked at right angles to the light, on the axis to the plug of the mirror frame. This causes the circle of light to pass away from and toward the operator. When the central position is found care must be taken not to disturb any of these arrangements.

The substage diaphragm should not be closed beyond the point where its shadow begins to show in the corners of the focusing screen. Definition may, however, be improved by placing an iris diaphragm, closed to the proper degree, in the path of the light near the microscope.

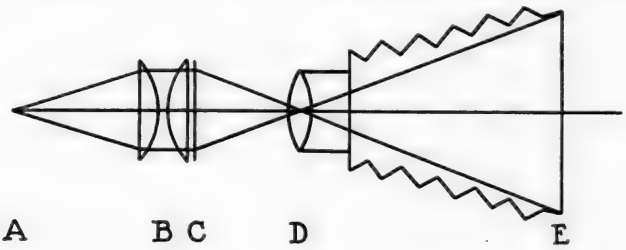
It is possible to get certain magnifications by using different lenses, each with its appropriate bellows extensions. If it is desired to secure

[1] If these condensing lenses are not available focus the light source so that a fairly large circle of even light is delivered at the mirror, which may then be removed and replaced by white cardboard or flashed white glass. Do not use a substage condenser. This arrangement will give a broad, even illumination that is satisfactory for low magnifications but will require rather long exposures with higher amplifications. Barnard also recommends the use of the curved mirror without a substage condenser.

the most critical central definition at a slight sacrifice of marginal detail, the lens of higher magnifying power is used, viz.: the one of shorter focus. The lens of lower magnification with longer bellows will give sharpness over a wide area with slightly less critical definition but with greater depth of focus.

It is requisite that both the stage which bears the specimen and the focusing screen be level and therefore parallel. The entire apparatus must be rigid and free from vibration.

A substitute homemade illuminating device consisting of a base with an electric socket and cord, on which rests a metal cylinder or narrow box, 6 to 7 inches high, may be used (5). A piece of glass should be supported about an inch above the top of the cylinder or box to hold




TEXT-FIG. 1

the specimen. Holes cut in the lower part of the cylinder and the space at the top will provide ventilation.

The so-called pulpit light which is used to illuminate papers on the desks of speakers may easily be adapted for such a purpose. It is thoroughly ventilated and the top may be reconstructed to form carriers for the glass stage. In these devices frosted bulbs of from 25 to 100 watts may be used. They are suitable for various magnifications. The entire stage and all of the specimen, except the part that is to be included in the picture, should be covered with black paper (plate 1, fig. 3).

Another method is to employ the principle of lantern slide projection with a lens of larger diameter than that of the object. Two plano-convex condensers are used. The figure shows the arrangement. *A* is the source of light, *B*, the condensing lenses, *C* is the object supported in a carrier close to the condensers, as the lantern slide is in a projector. The photographic lens *D* is placed where the image of the radiant would appear but varies with the magnification. *E* is the focusing screen.

This is best suited to rather low magnifications. Such an arrangement may be horizontal or perpendicular (1).

If color screens are used, they are usually placed in the path of light. Care should be exercised to prevent white light from reaching the plate. The most simple way of making the exposure is to block the light with a piece of cardboard. When the slide is drawn from the plateholder, a moment's pause is allowed for vibration to subside. The cardboard is then quickly withdrawn and replaced without jarring the apparatus.

Exposure may also be made by having a lens shutter on the camera at the risk of slight vibration, or suspended in the light beam.

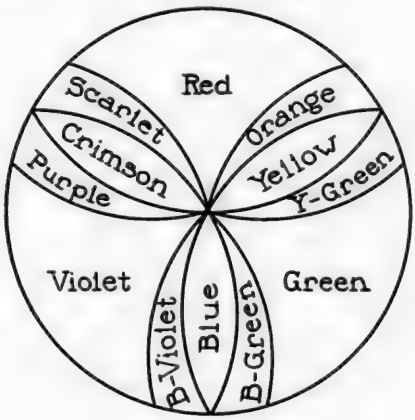
Every precaution should be taken against too brilliant illumination and since there is a tendency to overexpose in such work, it may be wise to use emulsions of considerable contrast. They are slow and will usually render the clear glass of the microscope slide a clean white in the print, which is very desirable. If the negative is of good quality but gives a gray background, it may be well to opaque the background. This must be done with care or the result will appear artificial.

Photomacrograms of microscope slides may also be made by placing the specimen in the negative holder of an Eastman or similar enlarger and projecting the image on a plate, with the color filter placed between the lens and the plate. The magnifications are limited by the focal length of the lens and the bellows extension. The specimen should be masked with black paper and care exercised to avoid too long exposure to the heat of the illuminating unit. The Leica and the other miniature enlargers may also be used if the microscope slide is not too large and as the light source is small, the danger of overheating is negligible. The masked specimen may also be arranged in an x-ray or similar viewing box and photographed with a camera with the appropriate lens. These methods are best suited to the low magnifications because the light is very diffuse, in which case it is best to place the color filter behind the lens of the camera. For photomacrographs of fixed specimens a horizontal apparatus may also be used. For very low magnifications the microscope must be removed from the optical bench and the specimen held in the perpendicular position by means of a diaphragm with clamps or other device. This must be placed at the proper distance from the lens, which is on the front of the camera, and from the illuminating system.

Double coated or nonhalation orthochromatic or medium slow pan-

chromatic plates should be used. The developing formulas contained in the packages have been carefully tested and are entirely satisfactory.

Much has been written on the use of color filters and good booklets on this subject are usually furnished by the makers. They are calculated for use with certain plates and should be used as directed. The author ventures only to give a few hints based on many years of experience. Biological sections are almost always stained in two or more colors, and blue and red are the ones most frequently used. This complicates the choice of the filter, because red and blue are complementary and a filter that will strengthen the red will weaken the blue and vice versa. If a diagram of the spectrum is arranged in the shape of a circle,




TEXT-FIG. 2

the complementary of each color will be on exactly the opposite side. This gives the following complementaries (6): Red to Blue; Orange to Blue-Violet; Yellow to Violet; Yellow-Green to Purple; Green to Crimson; Blue-Green to Scarlet (text-fig. 2).

A stained slide, like many colored objects, depends on color for contrast and not on tonal values. A red apple with green leaves or a section stained red and blue is very satisfactory to the eye, but the monochromic values of the two colors may be almost identical if photographed on ordinary films. This would be true also if the apple and leaves were photographed on commercial panchromatic material without the use of the correct filter. It is possible through the choice of the correct filter to overcome this lack of contrast by using one filter to darken the

apple and lighten the leaves. However, since red is a light color the picture would be more satisfactory with a light apple and dark leaves. For this purpose a G deep yellow or E orange filter should be used with a panchromatic plate.

The stained specimen, red and blue, is a similar problem. The microscope slide, stained, eosin-hematoxylin, red and blue-purple, will if normally stained photograph well providing the G filter (deep yellow) is used. This will only slightly weaken the eosin (red) and will strengthen the hematoxylin (blue-purple). The same treatment will also be correct for eosin-methelin blue, which is very satisfactory for study but hardly as good for photography, for the reason that the blue does not register as strongly as the purple when translated into black and white. The E filter (orange) or the E and G would be used. However, while strengthening the blue this would reduce the intensity of the red. Therefore, the E filter should not be used if the red stain is weak.

Giemsa stain, which is quite delicate, will require a good deal of strengthening G filters, E and G filters if strong in red, or an XI if weak in red.

In every case where increased contrast is wanted it is advisable to use the filter of the color complementary to the color to be strengthened, but only to the extent that it will not weaken the other color too much.

If the specimen is strongly stained and it is necessary to increase the detail in one color, a filter of that particular color or as near it as possible is used. For red, red or orange-red is recommended; for blue, blue or blue-green is suggested.

When the stain is "Weigert" or a modification thereof with heavy black on strong orange, good differention may result from exposure without a filter on an ortho plate. If the orange registers too strongly in the positive, a G filter will help to reduce its intensity. This is also true regarding Cajal stains and their modifications. Such specimens are extremely contrasty. Therefore the emulsions of the negative plate should have a long scale and the print should be fairly soft.

If the orange stain is weak, an XI filter will give it strength. Masson stain presents quite a problem with its bright red and green, dull magenta and rich purple. If the red stain is strong, an E filter will reduce the red-purple and magenta, while strengthening the green. An XI or B filter will reduce the green and strengthen the red-purple and magenta. If the colors are evenly balanced the D filter may be helpful. It will be

found that filters that are blue or partly blue will require increased exposure.

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# AUTOPSY ROOM PHOTOGRAPHY*†

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Autopsy room photography, while of great importance at times, is not routinely necessary. It is often much better to photograph an individual specimen with a special setup after the specimen has been fixed and cut or dissected to show its lesions to advantage. The photographs which must be taken at the autopsy table are those of parts of the body which are not removed. Pictures of external wounds taken before cleaning, also after they are cleaned to disclose their extent, are often valuable later as evidence. Fractures and lesions of the base of the skull which

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cannot be removed from the body must be photographed at the autopsy table or not at all. Often a series of pictures taken at short intervals to show the course of dissection of a lesion are invaluable and cannot be duplicated later by photographs of the specimens after they are removed.

There are many difficulties which must be surmounted. The subject, an inert, heavy body, cannot be posed, and the pictures must be made from any point of view or angle. Extra light is required and frequently there is not enough space in the usual postmortem room for many lights and large cameras. The progress of the pathological work must not be interfered with unnecessarily by photography. The tissues are wet and often covered with blood, so that altogether photographic conditions are at their worst.

The ideal setup may be outlined in the following manner: A five by seven or larger camera would be fastened to the end of a boom by which the camera could be pointed in any direction from any location. Film transport and changing to different types of film would be automatic. The movement of the boom would actuate an automatic focusing device. Shutter speed and diaphragm opening would be set by the action of an electric exposure meter, an arrangement which has recently been patented, and the diaphragm setting would always be small enough to insure adequate depth of focus. Filters would be built in and easily changeable. All of the lights would be suspended from the ceiling and movable in any direction.

Such a setup would be ideal and could do the necessary work in a minimum period of time. However, an apparatus of this type is yet to be perfected. We have found that a five by seven camera with any of the standard tripods or stands is a nuisance in the autopsy room. A large number of extra lights is also undesirable. Autopsy room exposures are mostly for record purposes and therefore need not be as perfect as the photographs of pathological specimens after removal from the body. The expense of taking numerous exposures for record purposes mounts quite rapidly. Therefore we abandoned the use of a large camera at the postmortem table and continued making our experiments with a miniature camera of popular make.

We know from experience that 35 mm. film will not produce the same sharp detail in an eight by ten print that is possible with larger negatives, but the ease of handling the camera from any position, the cheap negative material and the comparatively greater depth of focus are points in

favor of the small camera for this purpose. It is interesting to note that one can carry a camera into the autopsy room in one's pocket and take pictures through a fast lens with a fully opened aperture, with no extra lighting. After a few exposures, however, we discontinued this practice, since the definition and depth of focus were very poor due to the width

FIG. 1. A TYPICAL PHOTOGRAPH OF AN AUTOPSY SHOWING A DISTENTION AND PTOSIS OF THE STOMACH

of the aperture. For the lighting of the subject we now use No. 1 Photoflood bulbs and a Kodaflector without the stand. We also have a stand light with two flexible necks, each having a socket and a small metal reflector. One socket contains a 60-watt ordinary bulb which is used for local lighting of special locations. This is also employed for the

examination of special regions such as the base of the skull. The other socket contains a Photoflood bulb which is turned on only for the making of pictures. Five clear, daylight blue, 150-watt bulbs in reflectors above the table are the usual lighting facilities adequate for performing the autopsy and furnish a general light for the purpose of photography. The Kodaflector containing a No. 1 Photoflood bulb is held in the hand by an assistant wherever needed for pictures. We are able to obtain fully exposed negatives (by the use of a meter) at 5:12.5 at 1/20 of a second. This exposure time and lens stop gives good detail and depth of focus.

We use Superpan film for this work because we obtain a finer grain as a result than with other fast panchromatic films. The above exposure data pertains to this film. With the Agfa fine grain borax formula or with the newer Champlin Press No. 7 formula we get negatives from which we can make sharp five by seven prints. These prints are clipped to the autopsy protocols for filing. Prints of this size are large enough for record purposes and we find that they reproduce in medical journals as well as pictures from five by seven negatives.

Although admittedly these prints do not have the fine detail of prints made from larger negatives, the usual half-tone photoengraver's screen used in medical publications will cut out enough of the fine detail from the large negative prints so that the final result will not be very different.

The miniature camera as furnished does not, of course, allow as close work as a double extension view camera, but it is understood that a new attachment for these cameras permits a short extension for the lens. This extension is used with the range finder and permits the taking of closeups. Such an attachment is of great assistance in this type of photography.

The miniature camera is very valuable for taking record pictures in the autopsy room because of the low film cost and the ease of handling the camera from any angle and position about the table without disturbing the progress of the work. The camera can be taken to the postmortem room very easily. Simple lighting equipment will suffice since larger diaphragm openings can be used without sacrificing the requisite depth of focus.

# PHOTOGRAPHY FOR THE DENTIST*†

HARVEY W. SPENCER

Photography and dentistry may seem as far apart as the two poles, but in reality they are closely allied. The dictionary definition of photography is, "The *art* or process of making pictures . . . ," and of dentistry, "The *art* or science of treating the teeth. . . ." However, the mere fact that both are designated as arts would hardly convince one that they are intimately related, which is the purpose of this paper. Of course, the relationship is viewed from the standpoint of dentistry, to which photography is believed to be a valuable adjunct.

Both may be placed under the heading of fine arts, which is defined as, ". . . the application of skill and taste to the production of beautiful things. . . ." There is little doubt about photography in this respect, so let us briefly analyze dentistry from the same angle. All dentistry—extraction, for instance, is decidedly not beautiful if we ignore the nicety of technic, nor can we say that all photography, all sculpture, or all painting is beautiful in the strictest sense. Nevertheless, it cannot be denied that this term is applicable to the highest grade of dental restorations, whether they be made of gold, silver amalgam, porcelain or even vulcanite.

We often see, in the same mouth, silver amalgam restorations which have been made by two different dentists. One dentist has removed the decay, made a satisfactory cavity preparation and placed the amalgam in such a manner as to give good service, but without much emphasis on carving and polish. The other dentist has done all this, and in addition has carved and polished the filling so that it has the appearance of fine jewelry. With a few extra minutes of work he has accomplished that difference between a serviceable filling and a restoration which is beautiful as well as serviceable.

There is something about the curved symmetry of a nicely made filling that is pleasing to the eye in the same way that a well composed photograph appeals to the aesthetic sense, and here is the point at which these two arts closely approach each other. The same quality which prompts a dentist to be meticulous in his work and gain keen

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satisfaction from the results would enable him to derive similar pleasure from photography.

Dental training includes chemistry and physics, two of the fundamental requisites of the photographic process. The scientific methods, precision and neatness which are so necessary to the one art are as directly applicable to the other. Furthermore, every modern dental office is equipped with roentgen ray apparatus, which includes a dark room for developing x-ray films. The technic and equipment for developing these films are practically the same as for making ordinary photographs, although a slight addition is needed when making positive prints. Thus the dentist is already, to a certain degree, a photographer.

After this attempt to show the relationship of these two arts, let us consider the practical application of photography in dentistry. Many prominent men of the profession take pictures in their offices as a matter of routine. One writer on this subject, Futterman (11) is of the opinion that photography is too little used in the dental office and when used the technic is often poor. Meade (18) in a discussion of the subject says, "There is a very wide field for photography in all branches of dentistry. In many instances a photograph should be made a part of a patient's record and may be used as a study procedure, education of the patient, record of preoperative conditions and postoperative results, and legal protection."

Lischer (14), the famous orthodontist, says of photography, "It becomes an agreeable diversion to him who, in the love of his vocation, practices his art in accordance with its highest principles. It leads to a routine which seizes the unlimited opportunities for improving his services; it acquaints him with a wealth of material which heretofore passed through his hands unnoticed; nor does it fail to sharpen his critical judgement of the many malformations intrusted to his care. All in all, it is a commendable step forward, and exercises a refining influence on his subjective acumen."

Another advocate of the camera (2) bemoans the fact that an abundance of clinical material is observed every day by dentists and yet little of it is preserved for study. He thinks, however, that medical and dental men now realize that photography is a powerful ally in their professions. If this is correct we should soon see an increased number of clinical pictures in the offices of dentists and physicians, as well as in the literature of these professions; and, indeed, a review of dental

literature shows an increase in the use of photographic illustrations to substantiate important points (4). It is interesting to note that oral photography is said to be farther advanced in America and Germany than in Great Britain, and that British dental literature contains fewer photographic illustrations (15).

For the conscientious dentist who files accurate case histories of his patients photographs are indeed helpful, since they make a case history much more interesting and complete, and in a compact form that conserves filing space (4). Detailed descriptions may be eliminated to a great extent and the exact conditions quickly recalled by a glance at the photographic records. The fact that the camera never lies may serve the dentist in good stead in the case of an attempted lawsuit, and photographs are almost indisputable evidence before a court of justice.

If a dentist is interested in research of any kind and wishes to publish his findings in the various dental magazines, here again photographs come to his aid. An article illustrated by good photographs attracts the reader's attention, is more interesting to read, and explains the subject in a concise, clear manner unattainable in print alone. The writer of such an article acquires prestige in the minds of his readers, since the photographs indicate that he has dealt with the subject in a wholehearted and thorough manner.

Teachers of dental subjects almost invariably employ photographic illustrations when possible, as they eliminate much explanation and are more accurate and realistic than drawings and diagrams. There seems to be a touch of 'human interest' in a photograph which makes it more attractive to students, hence the large number of such pictures found in the better text books. Lantern slides on transparent positives are a popular method of classroom instruction, and general practitioners may profit by similar methods in educating the public, especially children, in the care of the teeth.

The mention of projection methods brings to our attention a comparatively recent addition to photography, or at least to amateur photography. This is the newly perfected color film which records images in their natural hues. Its use in the motion picture industry makes it readily available for movie cameras or miniature cameras which employ the standard 35 mm. film, but it can also be obtained in the larger sized films. Color films can be displayed only by transillumination and projection. However, the results more than compensate for this

difficulty since these pictures come as close as possible to a reproduction of the original. They are especially valuable in photographing pathological conditions in or about the mouth where color is often an important diagnostic factor.

Photography is more essential in some branches of dentistry than in others, but it can and should be used in nearly all branches. In orthodontia, for example, it plays a very important rôle. In prosthodontia and oral diagnosis it can also be used to great advantage, and while operative dentistry and exodontia probably require its services the least, it is still a valuable factor in showing changes from preexisting conditions. Let us enumerate a few of its uses in the different phases of the dental art.

To quote Sheffer (20): "Photography is a recognized aid in orthodontic diagnosis. It offers to orthodontics one of the most accurate, easy and satisfying methods of recording existing conditions of facial form. A knowledge of photography is one of the required attributes of an orthodontist." According to Lischer (14), plaster casts of the teeth cannot reveal facial deformities, and to procure the best results, "A copy of the facial configuration, either in the form of a plaster cast or a portrait photograph, has become an integral part of every important case history." He maintains that plaster casts are unpleasant to patients, difficult to make, too bulky to store and unnatural in appearance, while the use of portraits eliminates these drawbacks and fulfills every requirement.

Portraits may be advantageously used in prosthodontia to record the original facial contours before extraction, so that they may be accurately restored by the denture or bridge. One article (19), suggests sending a picture of the prosthetic patient to the dental laboratory instead of the usual explanatory note, so that the teeth may be arranged aesthetically to fit the particular case. Bruening (1) states that when a patient has been without teeth for some time the change upon insertion of dentures is sometimes embarrassing, but "before and after" photographs help him over this period. Also, when the dentures require rebasing or remaking after a period of years, the patient may be convinced of the need for this work by having him compare his mirror image with the pictures taken about three weeks after insertion. Bruening advises four views for this purpose:

1. Front view, teeth in gentle occlusion;
2. Front view, smiling;
3. Front view laughing—mouth and lips open;
4. Profile with teeth in gentle occlusion.

In diagnosing diseases of the mouth, accurate records of previous cases are of considerable assistance, especially in the more rarely seen diseases. Here the natural color photograph is undoubtedly superior to any other method in use and is always convenient when discussing these cases with other members of the profession. Filthy mouths, injuries, supernumerary teeth, malocclusions, ulcers, malignancies, or any interesting and unusual conditions about the mouth and face, can be quickly photographed and preserved for future reference.

In the fields of exodontia and facial surgery the dentist has occasion to observe a variety of interesting material, ranging from dental root cysts and oozing fistulas to extensive facial deformities. These larger lesions may be acute swellings, tumors, or harelip and cleft palate but, whatever they may be, photographs of the initial condition are very helpful and should be filed in case difficulties should be encountered during treatment. Facial surgery is most often used for the purpose of bettering the appearance of a patient, and improvements in the physiognomy are best demonstrated by portraits taken before and after the operation. Former conditions are soon forgotten by the patients and a photographic reminder often helps them to appreciate the efforts of the operator.

Even in the operative phase of the profession such a great change can sometimes be effected in the appearance of the teeth that it behooves the dentist to take "before and after" photographs for emphasis. Badly decayed or broken-down anterior teeth aesthetically restored in silicate or porcelain are especially good material, although extensive fillings in posterior teeth are also very eligible. Routine photographs of this nature are certain to make the dentist take more pride in his work and, consequently, strive to improve it. This fact alone seems sufficient reason for the use of photography in dentistry.

If a dentist so desires he can probably hire a professional photographer to do all this work, but there is no real reason why he should. After the initial expense of a camera and other equipment the cost is relatively low and one can get the pictures when and how they are desired. At least the technic of making the exposures may be acquired, and

the developing and printing may be left to the professional. However, as previously pointed out, many dentists already have most of the equipment and are partially acquainted with those processes.

Consideration should also be given to some of the different types of equipment and the various technics that have been used in this branch of photography. However, the minute details will be omitted since it remains for each individual to work out his own definite technic, starting with whatever equipment he may already possess. It is assumed that he knows the fundamental principles and terminology of photography, and has some general knowledge concerning the mechanism of a camera. The following are merely a few suggestions gleaned from the experiences of others as to how some of the different types of equipment may be used in dental photography.

The dentist has two classes of subjects to photograph:

1. Patients—animate subjects.
2. Models, appliances, specimens and radiographs—inanimate subjects.

Photographs of patients may be divided into two classes:

(a) Entire face, front or profile, to record anatomical landmarks, and an intermediate view to record some definite lesion on the face.

(b) Photographs limited to the mouth—lesions in or around the oral cavity (4).

This inclusive classification is a convenient way of showing the subjects which are of interest to the dentist.

Naturally, our first consideration is a camera and it is surprising what a variety of these may be used with the aid of a few attachments. They range in size anywhere from the large view or plate camera, down through the graflex and ordinary hand cameras to the miniature camera. There is also the Burton camera made especially for this type of work, which will be described later.

The first type to be considered is the familiar folding hand camera with which most of us are already acquainted. It is not necessary to have an ultrafast lens and shutter in this work, as our subject is comparatively motionless and well illuminated. The fast lenses are stopped down, or a small diaphragm opening is used in most of these exposures in order to gain greater depth of focus with consequently sharper detail and better perspective in the negatives. The lens need not be faster than f:6.3 for most pictures, but should be of the anastigmat type to obtain maximum sharpness throughout the picture. A cable release

for the shutter is almost a necessity in order to avoid movement of the camera, and the shutter speeds should include "bulb" and range from about one second down to the faster speeds which are very seldom used. However, practically all modern hand cameras possess these features when purchased.

Some of the higher priced hand cameras have a double extension bellows which enables them to be focused at a distance of a few inches. This is quite important, since the subject is often small and the finest details are desired. Of course, enlargements may be made of pictures taken at a greater distance, but the results cannot be better. If the camera is placed closer to the subject the source of light may also be placed nearer and thus increase the illumination, which is important. If the hand camera is not equipped with the long bellows, portrait and copying lenses may be bought at small expense. These slip over the regular lens and permit focusing from three or four feet to within eight or nine inches of the subject, thus meeting every requirement.

At these short distances a slight discrepancy causes the image to be out of focus, and this necessitates accurate measuring from the lens to the subject before each exposure. Also, the ordinary finder will not show the true field at very short range and the camera must be more or less aimed at the subject. To overcome these two difficulties a ground glass back attachment may be used in conjunction with cut film or film pack, and this also is included with some of the more expensive hand cameras. The ground glass insures a sharp focus and shows exactly what the picture will include before the exposure is made.

The large view cameras are probably used by the orthodontists mostly for portrait studies and are well suited for this purpose, since a sizable negative is obtained thereby which needs no further enlarging. The Eastman Kodak Company makes a clinical camera of this type which enables one to photograph to scale without resorting to measuring, that is, it can be adjusted to take one-half, one-quarter or one-eighth of the natural size (4). Small lesions about the face or mouth or even intraoral conditions may also be photographed by these cameras, although they may prove to be a trifle unwieldy when used for the latter purpose. One writer (21) suggests fastening a microscopical cover glass on the ground glass with Canada balsam to permit a clear view of the fine features and facilitate a sharper focus, and attributes to Ketcham the idea of examining the ground glass image under a tripod magnifying glass.

The modern miniature camera probably comes the nearest to being

universal in its application, as it may be used for practically any type of photography. The Leica, the Contax and the Exacta are among the more popular makes of these fine instruments. Conservation of space is usually required in a dental office and the small camera meets this requirement to the nth degree. Another advantage is the fact that the miniature camera lens has a short focal length which will record much detail and depth of definition without excessive stopping down of the diaphragm (12). This permits shorter exposure time with less danger of movement on the part of the subject. Most of these cameras use the standard cinema film, which is necessarily of fine quality as well as inexpensive, and a roll of 36 exposures may be placed in the camera to save loading time.

Other cameras that have been successfully used for this work are the Rolleiflex (15), the Auto Graflex (11) and the Burton Clinical Camera (3). The last-named instrument deserves special mention as it is well suited for intraoral photography. The camera itself is mounted in a large concave reflector which holds a photoflash bulb and throws the light around the camera, brilliantly illuminating the subject. Size $3\frac{1}{4}$ x $4\frac{1}{4}$ cut film or pack is used and most pictures are taken with the small aperture of f:45, which gives a depth of focus of four inches. The advantages of this camera are that it is small, simple, easy to focus, eliminates motion and requires no support other than the hands. Its disadvantages are that it must be more or less aimed at the object and that light parallels the lens, producing a flat picture with almost no shadows. However, the manufacturers are developing a means of overcoming this latter fault by shading the reflectors (3). This camera is not adapted to orthodontic work, but only to photographing small objects at short range.

Another point for consideration is the means of support for the camera, since the slightest movement spoils the sharpness of the picture. For the larger cameras a sturdy tripod or special stand is almost a necessity. However, these bulky objects are awkward and require space, so that where the smaller cameras are used other means may be profitably employed. Cotter (2) uses the bracket table arm of an S.S.W. Dental Unit with the aid of an Eastman No. 1 tilting tripod top, while Hemley (13) mounts his Leica on a small tripod which is set on the bracket table. The McCoys (17) employ a counterbalanced x-ray tube stand for both camera and light. Thus, with a little ingenuity the dentist can arrange the device best suited to his own office equipment.

Although the dental office is generally far better illuminated than ordinary rooms, the light is nevertheless inadequate for photography. If the subject is more brightly illuminated a shorter exposure and smaller diaphragm opening may be used, thus reducing the probability of movement and still obtaining depth and definition in the picture. There are several kinds of artificial light which are ordinarily employed. The McCoys (17) use an ordinary 500 watt lamp, while Cotter (2) prefers an old model Dentalscope mounted on a wall bracket. Creer (3) has ingeniously employed the Cutler lamp, a small water-cooled lamp of 750 watts which can be held in one hand while the exposure is made with the other.

While these types of lights serve very well, many dentists use special photographic lights which can be bought very reasonably under the names of Photoflood or Kodalite. These last two hours and deliver the equivalent of about 750 watts. Their rays have a greater effect on photographic emulsion than ordinary light has. Two of these bulbs in reflectors are generally sufficient (6, 7), with one on each side of the subject to eliminate shadows, although Golden (11) mounts three of them on the standard above his camera.

Another excellent method, although slightly more expensive, is the photoflash bulb. Each bulb is good for only one exposure and gives a very brilliant flash lasting for approximately one-fiftieth of a second. This practically eliminates the possibility of movement and allows the lens diaphragm to be stopped down to f:44 for intraoral pictures. Ordinary house current can be used to flash these bulbs, but a more convenient method is to use a flashlight battery holder attached to a reflector and a socket into which the bulb may be screwed. These bulbs seldom break when used, but it is well to interpose a glass shield when holding them close to a patient's face. In making the exposures set the camera on bulb. The shutter is opened just before the flash is set off and closed immediately afterward.

The choice of film has a very definite effect on the quality of the finished print and although this question cannot be dealt with in detail here, we will mention a few types that have been successfully used. Futterman (11) believes that for intraoral photographs orthochromatic film is preferable to panchromatic, since better contrast is obtained between the white teeth and the red soft tissues due to the fact that red is registered very lightly on the orthochromatic negative. For facial views he prefers panchromatic film because it does not show up blemishes

and pimples so readily. However, if it is necessary to accentuate skin lesions a contrast filter such as a Wratten B green filter or Wratten C blue filter should be used over the lens in conjunction with panchromatic film (22). Mackintosh (15) uses Agfa I.S.S. Supersensitive panchromatic film, while Creer and others (7, 8) use Eastman Portrait Superspeed film. The intraoral photographs used in this paper were taken with Eastman Commercial (orthochromatic) film, on the advice of Ennis (10). For model photography and transparent positives Eastman Process film is very satisfactory (9).

The length of exposure is naturally of the utmost importance. It depends on the intensity of the light, the diaphragm opening and the speed of the film. Exposure meters can be purchased which eliminate most of the guesswork from exposures, but these are not a necessity if one is willing to do a little experimenting at the expense of a few films. By recording the intensity of the light, diaphragm opening, kind of film and exposure time used, one may soon arrive at a definite technic suited to his apparatus and thereafter produce a fairly uniform quality of negatives. The photoflash bulb is an advantage in this respect. Since the intensity of the light is always the same and lasts for one-fiftieth of a second, two factors, time and illumination, are taken care of. This leaves only the diaphragm opening to be considered.

Other technical factors influencing the quality of the picture are the kind of developer and sensitized paper used. Here again we will not go into detail further than to say that x-ray developer is satisfactory where contrast is desired, although it is an advantage to dilute it in certain cases (6). A photographic paper with a glossy finish is usually considered the best for clinical pictures (10) as it gives the maximum sharpness of detail.

At this point it may be appropriate to give a short description of the apparatus used in taking the few pictures accompanying this paper. A 4 x 5 Korona view camera of rather ancient lineage was employed in conjunction with a Burke and James Ideal copying lens for the intraoral photographs.

The camera was equipped with a double extension bellows. However, it was found that the copying lens greatly shortened the focal distance, thus making the apparatus less unwieldy and easier to focus, as well as improving the perspective of the pictures. The camera was mounted on a homemade wooden slide, which in turn was fastened to the top of a

tripod. This slide enabled the camera to be moved back and forth horizontally while the tripod remained stationary and greatly facilitated focusing.

Photoflash bulbs in a flashlight battery holder provided the light for the intraoral photographs, in which Eastman Commercial cut film was used. For the facial views Photoflood bulbs and Agfa Supersensitive Plenachrome film were employed. The printing was done on Eastman Glossy Velox and Glossy Azo papers, between which there seemed to be little choice, and the gloss was imparted by rolling the prints out on a waxed ferrotyping board.

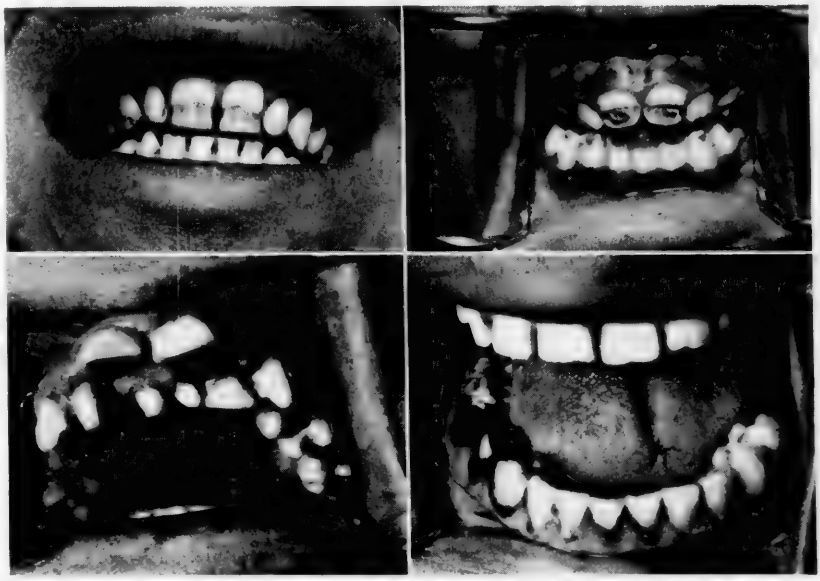

FIG. 1

It has been stated (8) that the object of clinical photographs is to show structural details in an impersonal manner, and that only the area of interest should appear in the finished print (4). This is accomplished by masking or enlarging certain portions of the negative when printing, and also by properly arranging the subject and the camera before taking the picture. The various technics of accurate orthodontic photography are too numerous and lengthy to discuss here, but they may be found in the references listed in the bibliography. Facial views for other purposes, such as prosthetic or facial surgery, are fairly simple to obtain after a little experience. The points to be observed are in brief:

1. Correct positions of patient and camera (20). (Less distortion of facial features will occur if the subject is farther distant from the lens.)
2. Arrangement of lights to prevent undesirable shadows.
3. A suitable background of plain cloth, such as fuzzy flannel, placed at least three feet back of the patient's head (21).

For a variety of reasons it is often desirable to obtain photographs of specimens and models. The following is an outline of the technic described by the Eastman Kodak Company (16) for photographing orthodontic and laboratory models:

1. Models trimmed orthodontically.
2. White plaster models painted to bring out contrast if desired. Teeth left white, gum tissue painted gray, and support a darker gray.
3. Background of black bristol board on a suitable support.
4. Models positioned to best display the area of interest.
   (a) Occlusal view
   (b) Front view
   (c) Three-quarter view
   (d) Side view.
5. Kodalites placed above and at each side of the models, one two feet and the other three and one-half feet distant.
6. Camera tilted vertically and pointed downward at models.
7. Area of interest centered on the ground glass.
8. Lens stopped down to f:45. The exposure is slightly longer for colored models than for white.

The technic of making transparent positives and lantern slides is just as simple as that of regular prints, and the procedure nearly the same (9). The advantage of transparent positives is revealed in this quotation: "When such prints are placed before illuminators, all recorded detail shows with greater brilliance than it is possible to obtain from glossy prints viewed by ordinary reflected light" (9). They are mounted in cardboard holders and protected in handling by special acetate sheeting or varnish. Lantern slides are printed by contact or projection on sensitized glass plates. After varnishing and masking they are protected by being bound to a cover glass (21).

As stated before, the object of this paper is to stimulate interest in dental photography rather than to delve into the details of technic,

since these may be elicited from the many articles written on this subject or discovered by experimentation. After a person's interest is aroused, information seems readily available.

In conclusion, there remains another thought which should not be overlooked. It has been said that every man should have a hobby. This was never more true than it is in the busy world of today, where a hobby should provide a quiet diversion. The dentist is necessarily confined indoors, where he looks at small objects at close range the major part of his time. Photography, as a hobby, would encourage him to get out of doors for some much needed relaxation, and teach him to observe and appreciate the beauty to be found in the larger things in nature. If he already has a hobby he should realize that it would not suffer from photography, as snapshooting can add zest to almost any hobby.

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# A BINOCULAR MICROSCOPE FOR VIEWING LONG WAVE-LENGTH STEREORADIOGRAPHS*†

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A radiograph is a shadow picture, with the projections of the various portions of the subject superposed upon a plane film or plate. A radiograph does not show perspective as does a camera photograph and gives no reliable impression of the relative positions of the parts of the subject in space. To overcome this deficiency the method of stereoradiography is used, whereby two radiographs are made from two positions of the x-ray tube. By viewing these radiographs in a stereoscope, the observer sees the x-ray representation of the subject in solid dimensions.

The principles of stereoradiography have been carefully worked out for

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medical use and require but little modification in adapting them to x-ray radiography of small specimens. Long wavelength radiographs are made on fine-grained plates or films and are best viewed under magnification, ranging generally from 5 to 30 diameters. It may be assumed that the enlarged image will be viewed at the most comfortable distance for the discrimination of fine detail, that is, at approximately

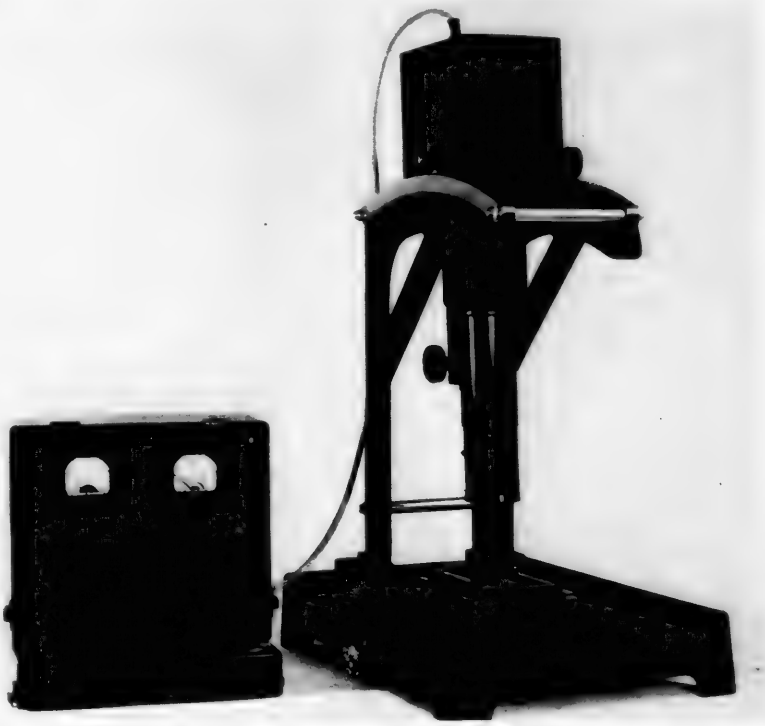

FIG. 1. RADIOGRAPHIC APPARATUS WITH THE X-RAY TUBE AND TRANSFORMER ASSEMBLY SUPPORTED ON AN ARC

15 inches. For the average interpupillary distance of $2\frac{9}{16}$ inches the lines of vision of the two eyes will form an angle of 10 degrees in viewing an object at a distance of 15 inches. In exposing the stereoscopic radiographs the two tube positions should also be separated by an angle of 10 degrees so that the x-ray projections will correspond to those which would be received by the observer's eyes in viewing the specimen itself. Under these conditions the stereoscopic image will appear in approxi-

mately the correct proportions. If the two tube positions are separated by a lesser angle, the resulting stereoscopic image will appear too thin; if a greater angle is used, the image will appear too thick. The latter result may be advantageous in the examination of thin specimens, where the exaggerated depth effect serves to distinguish more clearly the different levels in the subject.

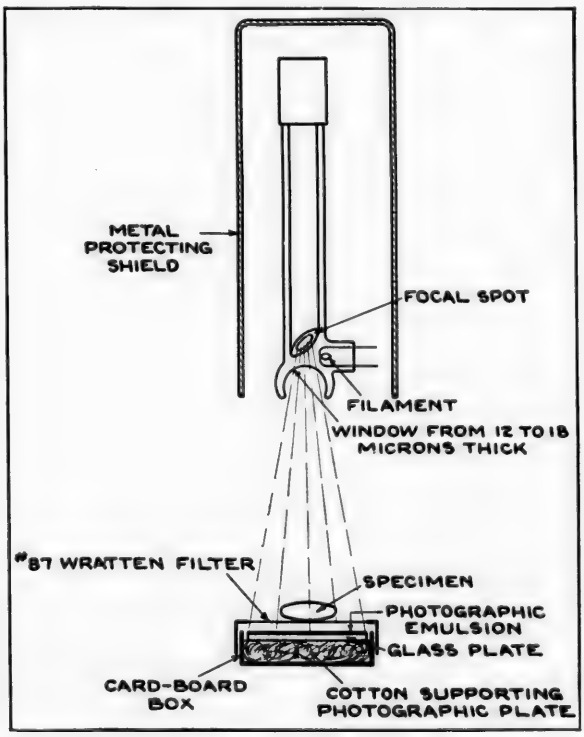


FIG. 2. ARRANGEMENT OF TUBE, SPECIMEN AND FILM IN MAKING A LONG WAVELENGTH RADIOGRAPH

Figure 1 shows the complete radiographic apparatus with the x-ray tube and transformer assembly supported on an arc, permitting a stereoscopic shift as far as 10 degrees on either side of the central position. Figure 2 illustrates the arrangement of tube, specimen and film in making a long wavelength radiograph.

Photographic enlargements, if of suitable size, may be viewed in an

ordinary hand stereoscope but in the larger sizes may be examined more appropriately in a Wheatstone stereoscope. A more convenient procedure, however, consists in viewing each radiograph of a stereoscopic

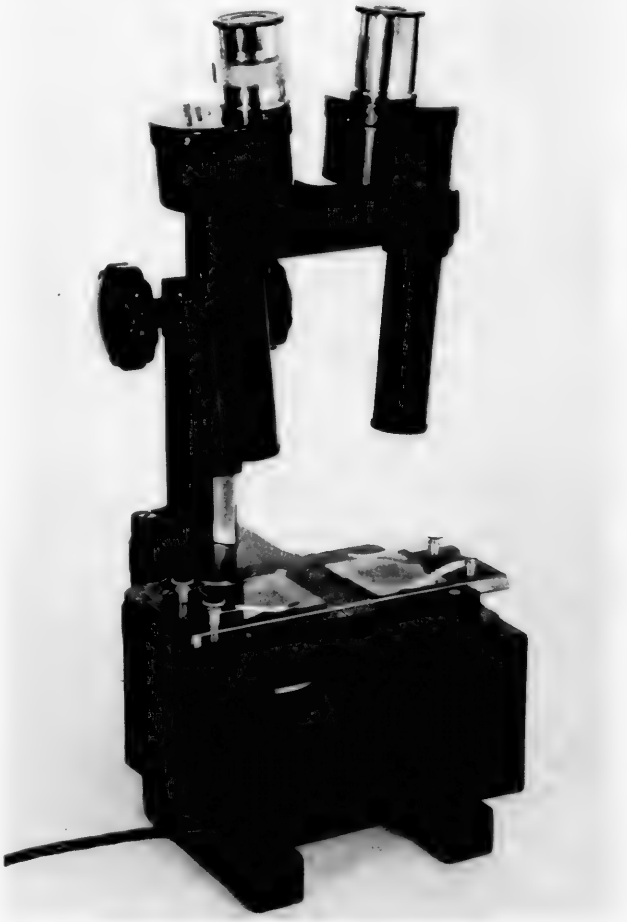

FIG. 3. STEREOSCOPIC MICROSCOPE

pair through its own lens or microscope, thereby obtaining a magnified stereoscopic image directly from the original radiographs. For this purpose a stereoscopic microscope (fig. 3) was constructed according to the author's specifications by the Bausch and Lomb Optical Company. It

consists essentially of two similar microscopes mounted on one standard, through each of which one of the stereoradiographs may be viewed, one by the right eye and one by the left. Prisms of the eyepieces may be shifted laterally to provide for different interpupillary separations. The stereoradiographs, one under each objective, may therefore be brought into register in order to fuse into the stereoscopic image. Each objective covers a field of 18 mm. The stage, carrying the two radio-

FIG. 4. SPECIAL STEREOSCOPIC PLATEHOLDER

graphs, is readily movable in all directions in its own plane and permits an area 40 mm. square to be examined without shifting the positions of the radiographs on the stage. A pair of erecting prisms are used in each microscope.

Various degrees of magnification are available by the use of different eyepieces, but magnifications of 20 to 30 are satisfactory with this instrument.

The special stereoscopic plateholder shown in figure 4 enables both

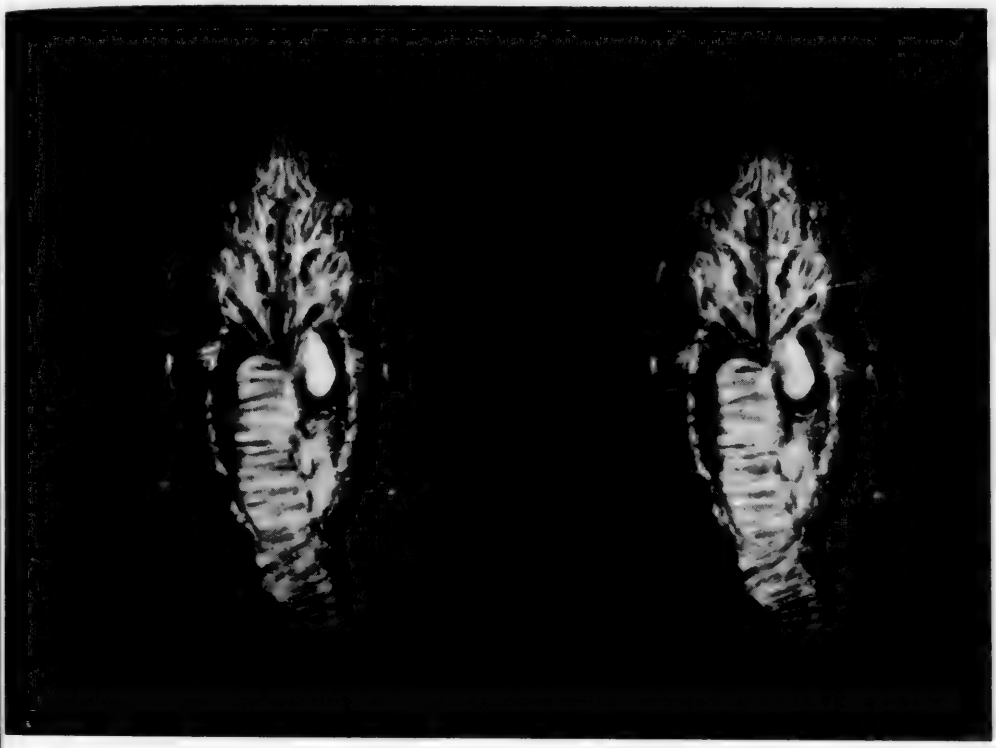

FIG. 5. LONG WAVELENGTH STEREORADIOGRAPH OF A FEMALE COCKROACH (BLABERUS CRANIIFER)

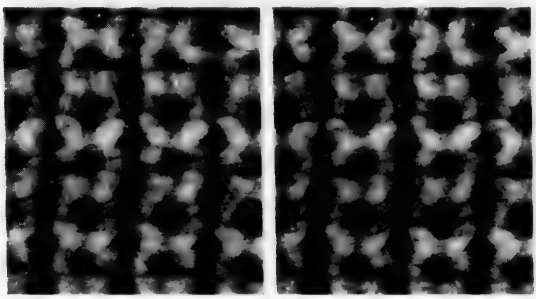

FIG. 6. LONG WAVELENGTH STEREORADIOGRAPH (25×) OF KNITTED RAYON AS SEEN THROUGH THE STEREOMICROSCOPE

radiographs of a stereoscopic pair to be made on one plate. With the aid of stops on the base of the apparatus the plateholder may be shifted to give the correct separation of the images for viewing in the stereoscopic microscope. This feature greatly simplifies the stereoscopic registration of the two radiographs. The exposure made in the right-hand tube position is viewed by the right eye and the radiograph exposed from the left-hand tube position is viewed by the left eye.

Figures 5 and 6 illustrate several applications of stereoradiography. The improvement of the stereoscopic method over the single radiograph is especially marked in the examination of textile samples, since it permits the paths of the threads to be visualized in the depth of the sample as well as in its lateral extent. The effects of crêping and other distortions in the weave are strikingly portrayed by this method.

In studying the distribution of plant sprays on leaves, the stereoscopic method enables one to distinguish between sprayed areas on opposite sides. The relations of the parts in insect anatomy are clearly shown in the stereoscopic view.

In short, the stereoscopic procedure may be considered an essential part of long wavelength radiography in practically all its applications and the stereoscopic microscope provides the most suitable means of viewing the stereoradiographs.

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## MOTION PICTURES OF TISSUE CULTURES (CILIATED EPITHELIUM)*

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From a photographic standpoint this article describes a motion picture which represents an excursion into the problem of time lapse cinemicrography with such apparatus as could be found on the market or could be turned out by the type of shop usually attached to a research institution.

Two years ago the author and one of his colleagues (1) succeeded in growing ciliated columnar epithelium from the nasal sinuses upon artificial media. It was highly important for the study of sinus infection

* Read at the 1937 Convention of the Biological Photographic Association.

and of postoperative healing to obtain some conception of the way in which these growing strands and sheets of epithelium conducted themselves, and to watch the supporting stroma of connective tissue prepare their progress.

The problem involved the erection of an available Bell and Howell 70DA camera in such a way as to take from one to six frames per minute through a microscope standing in a sterile incubator, and to continue this procedure without serious intermission for several days and nights. As the medium often became liquefied it was necessary to maintain the incubator free from vibration and, since the tissue was light and heat sensitive, relatively short periods of illumination were essential.

Inspired by a memorable visit to the late Doctor R. G. Canti of St. Bartholomew's Hospital in London, the author had induced the authorities of the Oscar Johnson Institute, when they erected their new building, to include in their plans a subcellar laboratory and darkroom in which a vibration-free table could be constructed. The latter, together with the apparatus to be described, was made in the Institute shop from the author's sketches and installed in this room.

The vibration-proof table is supported upon three pillars composed of successive layers of concrete, rubber and cork. The two end pillars are placed beneath the extreme ends of the table at right angles to its long axis. The middle one is in the shape of a "V" which effectively damps thrusts from all directions. The layers of concrete are of various thicknesses and differ in each of the three pillars. In this way the possibility of any fundamental period of vibration of the table top is eliminated. The incubator, the lamp and the cooling cell stand on this table; the microscope is within the incubator.

The camera, mounted on a heavy sheet of metal, is suspended from the ceiling and swings above the microscope without contact. As a result the vibration from the operation of the camera cannot be transmitted to it. A reflex focusing device is used.

When the camera supports were completed they were found to be so heavy that pushing them about by hand was almost impossible and attended by a great deal of jarring. Simple mechanical arrangements were attached so that the camera may now be shifted as little as one millimeter in any direction with great accuracy.

In view of the fact that it was necessary to release the shutter by means of an electromagnet and since this Bell and Howell camera has

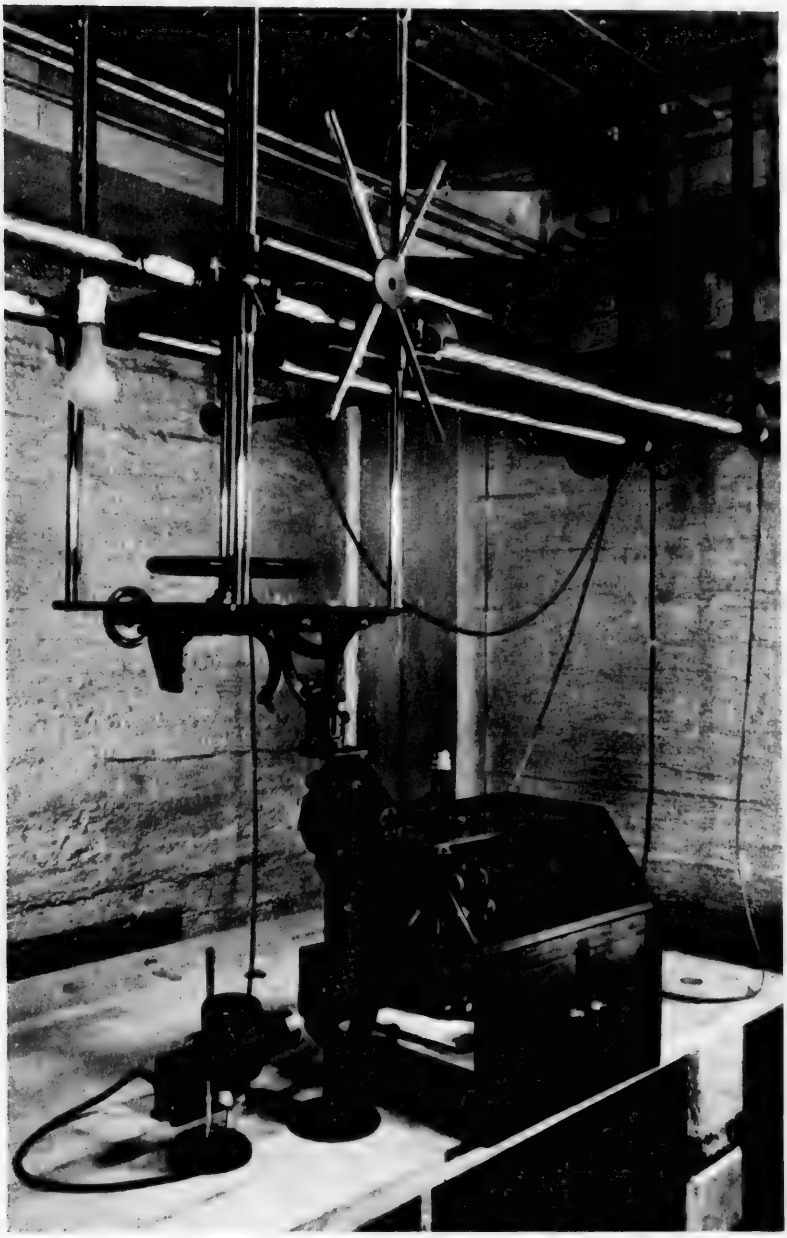

FIG. 1. The incubator, containing the microscope, stands on a vibration-free table. The camera, swung from the ceiling, is not in contact.

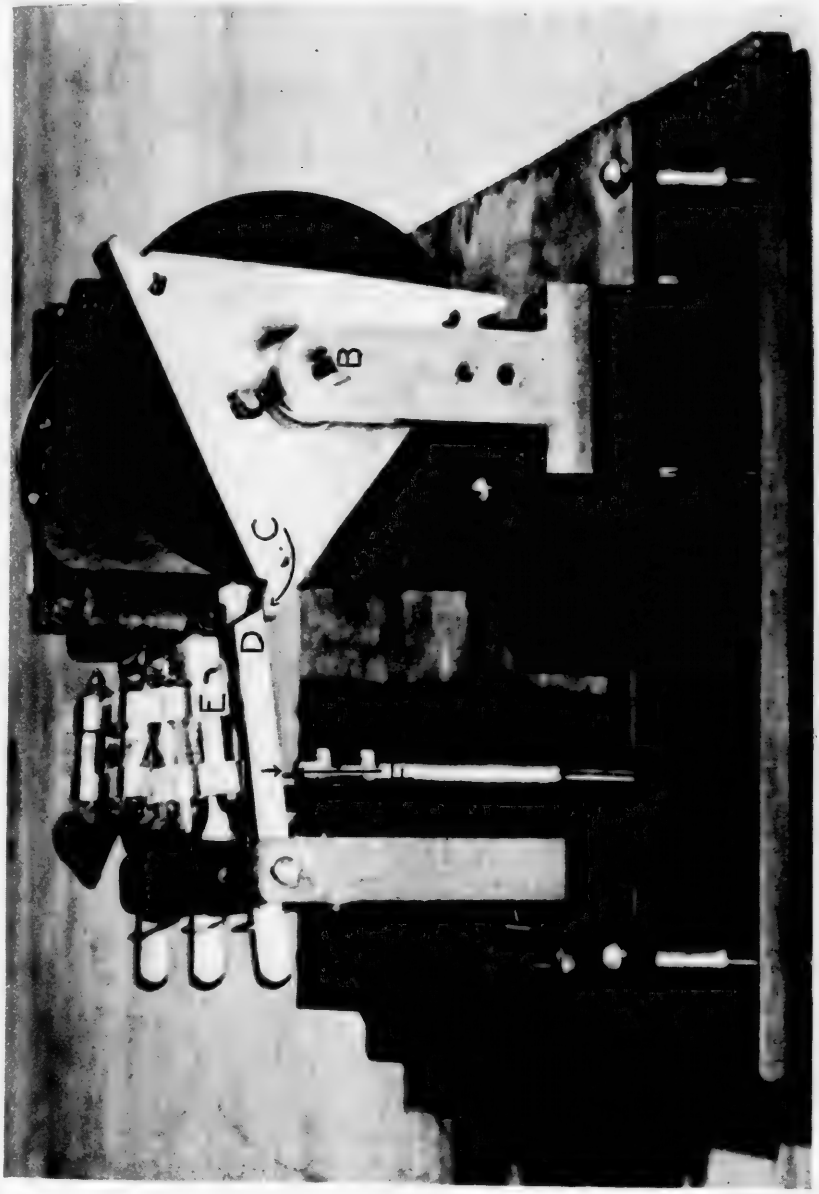


FIG. 2. THE TIMING DEVICE

*A*, motor; *B*, shaft; *C*, cam; *D*, camera contact (make); *E*, mercury switch for illuminant only; *F*, camera contact (break).

no single frame exposure device, the construction of a timer was required which would deliver an instantaneous impulse. This was done as follows:

The motor A (fig. 2) was removed from a cheap self-starting kitchen clock and mounted upon a bakelite base. To its shaft, geared to one revolution per minute, was applied a longer shaft *B*, the two being insulated from one another. Upon this shaft revolve double cams *C* so designed that they will deliver one, two, three or six pairs of contacts per minute.

One side of the cam tilts a lever bearing a mercury switch E, which controls the lamp. It lights the lamp 1.5 seconds before the second cam makes the camera contact through a second lever D. This lever is so constructed that, as the cam makes contact with it, a second contact *F* is broken and produces the required instantaneous impulse. The light is switched off as the mercury returns to level and thus completes the cycle.

The light source is a 6 volt condensed filament incandescent lamp operating through a transformer on the 110v line. The camera magnet is activated from a 45v radio battery.

For most work cumbersome vibration-proofing is unnecessary and the apparatus consists simply of the timer and a remote control magnetic device. There is such a device on the market. It is advisable to include an emergency cutout switch in the camera circuit so that useless frames will not be clicked off in the event of an error, or if it should become necessary to keep the prismatic finder mirror in the beam for a time for focusing.

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# TRANSURETHRAL CINEMATOGRAPHY*

## By Means of Moulage

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*Des Moines, Iowa*

Transurethral resection of the prostate gland is a surgical method of dealing with prostatic obstruction which has been developed within the past few years. This method of removing small pieces of obstructing tissue through a cystoscopic punch is being used today in many cases where prostatectomy (complete removal) was formerly necessary.

The problem of illustrating the technic of this operation is not as simple as cinematography of ordinary open surgical operations. Only the external movements of the operator are visible to the observer. The field of operation is seen only by the surgeon himself. The following article describes a method of illustration for these internal views as applied to the operation of the Bumpus and the Thompson direct vision resectoscopes.

Motion pictures through the cystoscope or resectoscope are theoretically possible but actually impractical for the following reasons: (1) The cystoscope itself furnishes a field of vision only $\frac{1}{4}$ inch in diameter. (2) The light furnished by the cystoscope light bulb is insufficient for good cinematography. (3) A beam-splitting device making possible simultaneous observation and photography would further reduce the light. (4) The attachment of a motion picture camera to the proximal end of the resectoscope would prove so clumsy that operation would be impossible.

The only alternative then is to fake the internal views by means of moulage. An article written by Mr. Heinz Rosenberger and published in the Journal of the Biological Photographic Association, December, 1933, was very helpful in carrying out this work. The method described in this article illustrated the technic of the Collings resectoscope. In this instrument the cutting is done by a wire loop or blade carrying a high frequency cutting current, and the visual system contains a lens. On the other hand, in the Bumpus or Thompson instruments the cutting is done by a cold tubular knife, and the visual system is direct and without lens magnification.

* Received for publication, July 19, 1937.

In the lens cystoscope the field of vision consists simply of the magnified image of the object, because the objective lens is situated at the distal end of the instrument and is thus actually within the bladder. In the direct vision cystoscope the operator looks through a long narrow tube filled with water and sees the inside wall of the tube as well as the object being examined. This type of instrument thus lends itself very well to imitation. Since the inherent problems are different in the various instruments mentioned, the method used will be described.

The setup is illustrated in the accompanying photograph. The Cine-Kodak model B was mounted on a wooden track which allowed

FIG. 1. APPARATUS USED SHOWING CINE-KODAK, METAL TUBE, ZEISS FLASK AND PLASTELINE MODELS OF THE PROSTATE AND BLADDER

free horizontal movement. The metal tube representing the resectoscope was $1\frac{1}{2}$ inches in diameter (5 x the diameter of the resectoscope). The camera focus was set at 2 feet, thus bringing objects 2 inches beyond the end of the 22 inch tube into accurate focus.

The model consisted of two parts representing the prostate and the bladder, both mounted on frames which could be adjusted horizontally on a track or removed separately. The prostate was moulded in a metal can representing the prostatic urethra, into which the lobes of the enlarged prostate projected. The urinary bladder was modeled on a wooden base. Both models were made of gray plasteline and were constructed to scale (5x) from studies of autopsy specimens.

In order to give the impression of lateral movements of the resectoscope it was found necessary to move the end of the metal tube by hand, leaving both camera and models stationary. If the camera and tube were moved together as a unit, the model itself appeared to move on the screen and produced an undesirable and unnatural effect.

In order to keep within the motion picture frame (and avoid going off the screen) a wooden upright was used to support the metal tube. This had a rectangular opening through which the metal tube passed and limited the lateral excursions of the tube. A piece of cardboard through which the tube passed was fastened to this board with thumb

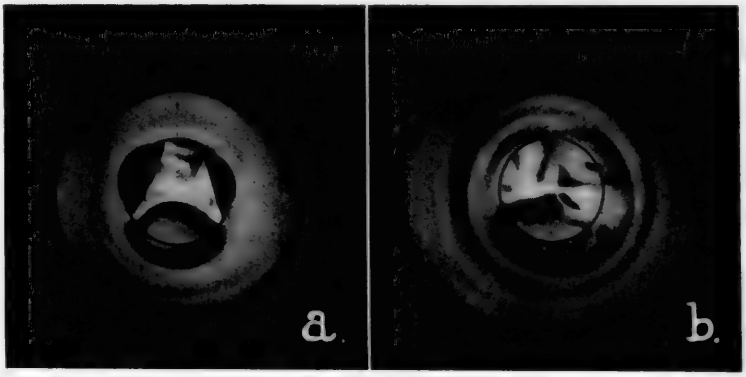



FIG. 2. THE OPERATING FIELD AS SEEN THROUGH THE DIRECT VISION RESECTOSCOPE (16 MM. FILM ENLARGEMENT)

a, The prostate showing hypertrophy of median lobe.

b, The bladder showing right ureteral orifice. Note: The blurred periphery represents the shiny inside surface of the resectoscope.

tacks for centering purposes. With this arrangement the image could be centered at will or moved about without going off the screen.

Illumination was furnished by two Photoflood bulbs. One was placed directly in the median line over the model of the prostate; the other was placed laterally to enhance the shadow effect on the model of the bladder. The gray color of the plasteline gave the desired contrast in terms of light and shade.

The scenes shown by means of the model were: (1) Examination of the prostate showing trilobar hypertrophy. (2) Examination of the bladder showing marked trabeculation of the bladder wall, ureteral ori-

fices and one diverticulum. (3) Engagement of tissue in the fenestra of the resectoscope followed by resection with the knife punch. (4) A final shot showing the new channel which had been made in the prostate to relieve the urinary obstruction.

In order to create the illusion of looking through a cystoscope certain shots were photographed through water. A special bottle with plate glass sides was used for this purpose. The slight refraction caused by the water was sufficient to soften the characteristic sharp outlines which often betray the most faithfully constructed model. To enhance the effect of looking through water bubbles were blown in the water to give the effect of the air bubbles which normally are seen flowing through the resectoscope tube.

Finally, the model shots were spliced into a film which was taken in the operating room and showed the actual operation. The combination of both internal and external shots produced a film which was received with great interest by urologists, many of whom were unaware that a model was being used.

Although a subject of this kind may be successfully photographed on the regular reversal films, the writers chose positive film for this work. Besides being less expensive it allows testing of the setup lighting and focus, and gives good contrast.

The first test was made for exposure, the diaphragm being set at several openings and the stop number recorded. The film was developed to a negative in D-72 (Eastman) diluted about 1 to 3. Development seemed complete in about three minutes. After the negative had dried a print was made to determine the best results and f:2.8 proved most satisfactory.

Following this first test other strips were run to test the depth of focus, field, illumination, contrast of lighting, etc. All further tests and the final negative were processed as stated above. The print was made on positive film and developed for six minutes in D-16 (Eastman).

The scenes of the operator using the resectoscope in the operating room were photographed on supersensitive negative film with three Photoflood lamps. From this a positive print also was made. If reversal film is used, the moulage scenes must be spliced into the outside scenes which are reversed from the way they were taken. Otherwise, the emulsion side of the film will not remain toward the screen when the picture is projected. Since the model is symmetrical in this case such reversal is not objectionable.

# PHOTOGRAPHIC TECHNIC, NEW PROCESSES AND EQUIPMENT*†

## PHANTOM PHOTOGRAPHS. A METHOD OF SHOWING RANGE OF MOBILITY BY MEANS OF DOUBLE EXPOSURE

F. R. HARDING

*Boston, Mass.*

Intentional double exposure, or phantom photography, is frequently employed to demonstrate the range of mobility in joints of the extremities and the body. The result is not always satisfactory, due to improper immobilization of the joint nearest the part involved.

The necessary apparatus is simple and will already be found in many institutions. The background must be black. This is most essential. For certain types of phantom photography a long black gown with full length sleeves and a one yard square of black cambric will be found necessary. The black gown may be a precaution gown dyed black, or one may be made from black cambric. For wrists, elbows, ankles and knees the black gown is not essential, but if it is available it will be found very useful at times.

All phantom photographs require the services of two persons, one to operate the camera and one to hold the patient.

To produce phantoms of the knee or ankle a stool is placed on the examining table and the patient is seated laterally in relation to the camera. If the phantom is to be made of the ankle, the assistant should firmly hold the leg just below the knee so that there will be as little motion as possible above the ankle joint. This is frequently accomplished by reaching through under the seat of the stool while the assistant stands behind the patient. The unaffected leg is placed out of the range of the camera by draping it with black cambric or by having the patient flex the leg and hold it in the flexed position with the hand. Dorsiflexion and plantar flexion are the two positions for the ankle. The action is rehearsed before the photographs are made and the operator should watch for unwanted motion in the lower leg. The camera is carefully focused to include sufficient area so that when the foot is dorsiflexed the entire foot will appear in the photograph. Either position

* From the Department of Photography, Children's Hospital.

† Read at the 1937 Convention of the Biological Photographic Association.

may be photographed first. The position is then changed and the second photograph is made on the same film. It is understood, of course, that

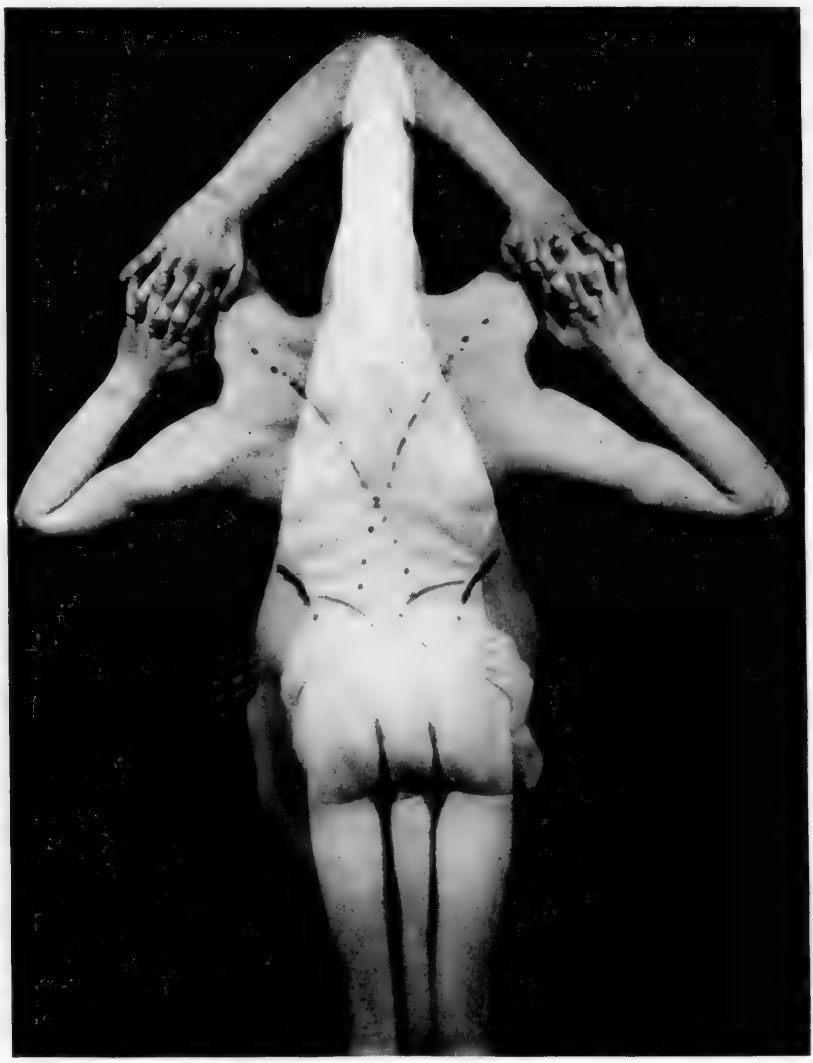


FIG. 1. A PHANTOM PHOTOGRAPH OF POTT'S DISEASE, POSTOPERATIVE SPINAL FUSION

the focus of the camera is not to be changed between the two exposures. They are made one or two seconds apart. The same technic is employed for the wrist, elbow and knee.

Recently phantom photographs have been made of the neck and the spine with considerable success. Tuberculosis of the spine, spinal fusions, scoliosis, etc. are graphically portrayed by phantom photography. This method has also been employed in torticollis and diseases that cause limitation of motion in the cervical spine. The spine and neck bring into use the previously described black gown and cloth square. For posterior phantoms of the complete spine the assistant should wear the black gown and cover his head with the black drape. He kneels and faces the patient, whose back is turned toward the camera. The patient is held firmly at the hips and bends laterally left and right. If a lateral viewpoint is desired, the patient is held at the hip line and the assistant stands on the side away from the camera. The patient bends forward and backward with the hands clasped at the back of the neck to keep them out of the way. For neck phantoms the shoulders should be immobilized so that only the head and neck are free to turn. The head may be tipped to the left and right and also rotated.

The principal thing to bear in mind when making phantoms is *immobilization* of the proper part. For ankles the proper point is just below the knee; for knees it is below the hip; for wrists it is below the elbow; for elbows it is below the shoulder; for the complete spine it is at the hip line; for the neck it is the shoulders. In other words, for extremities immobilize above the joint involved and for the spine immobilize below the joint.

If many phantom photographs of the spine and neck are to be made it would be a simple matter to construct a platform having an upright at the back with two arms projecting from it which are adjustable for width and height. This would mechanically immobilize the patient.

This process undoubtedly possesses a number of other applications which have not been spoken of here. It offers an extremely good method of demonstrating the range of motion in almost any joint.

# Association News

The Seventh Annual Convention of the Biological Photographic Association was held in Rochester, N. Y., September 23–25, 1937. An exceptionally instructive program and Salon was held. The Salon drew many fine examples of medical and biological photography, both in color and black-and-white. The series of motion pictures shown were predominantly in color.

The 1938 convention will be held in Philadelphia, Pa. It was the consensus that the Philadelphia members would conduct a most interesting and instructive meeting.

The officers elected for the forthcoming year are as follows:

Mr. Louis Schmidt, President
Mr. Leo C. Massopust, Vice President
Miss Anne Shiras, Secretary
Miss Stella Zimmer, Treasurer

* * *

Members are urged to prepare for the 1938 Salon. Negatives should be set aside which fully meet the Salon requirements and sufficient time allowed to make and mount prints so that representative work may be submitted when the call goes out next year. The Association is anxious to establish the Salon as the outstanding exhibit of medical and biological photography held annually in this country. All members are urged to participate in this event.

* * *

The only award in the hanging of prints at the 1937 Salon was the honor of exhibition. The following exhibitors' work was on display:

F. R. Harding, Children's Hosp., Boston, Mass.
S. J. McComb, Mayo Clinic, Rochester, Minn.
Dr. Bruce Mayne, State Hosp., U. S. Public Health Service, Columbia, S. C.
Dr. L. W. R. Jackson, Dept. of Botany, Univ. of Pennsylvania, Philadelphia, Pa.
R. W. St. Clair, Boston, Mass.
J. V. Butterfield, Bausch & Lomb Optical Co., Rochester, N. Y.
Dr. Silvestr Prát, Prague, Czechoslovakia
Louis Schmidt, Rockefeller Institute for Medical Research, New York City.
Florence Melvin, Dept. of Medicine, Ohio State University, Columbus, Ohio
Julian A. Carlile, Rockefeller Institute for Medical Research, New York City
Glenn Mills, School of Medicine, Univ. of Colorado, Denver, Col.
W. Chace Lown, Massachusetts General Hosp., Boston, Mass.
Adolph Marfaing, Institute of Ophthalmology, Columbia Univ., New York City
Leo C. Massopust, School of Medicine, Marquette University, Milwaukee, Wis.
Dr. Norman R. Goldsmith, Pittsburgh Skin & Cancer Foundation, Pittsburgh, Pa.

G. M. Busanovich, Germantown Hosp., Philadelphia, Pa.
Stella Zimmer, School of Medicine, Syracuse University, Syracuse, N. Y.
Chas. S. Foster, Rochester, N. Y.
Frank N. Ruslander, Harper Hosp., Detroit, Mich.
H. S. Hayden, Montreal Neurological Institute, Montreal, Canada
Dr. J. M. Bruner, Des Moines, Iowa
Dr. Arthur Proetz, St. Louis, Mo.
C. E. Arnold, Dallas, Texas

* * *

Various members of the Association were successful contributors to *U. S. Camera 1937* and the Royal Photographic Society Exhibition.

* * *

Our President, Mr. Louis Schmidt, spent the week-end of October 9 in Philadelphia visiting a number of members and friends of biological photography, with a view toward the meeting in Philadelphia next year. The Philadelphia members are very enthusiastic at the prospect of the next convention being held in their city and consequently cordial cooperation with the national body has been extended. A preliminary meeting will be held in Philadephia in connection with the exhibition of the Traveling Salon to be held either in the hall of the County Medical Society or at the University of Pennsylvania. Everyone who is interested should communicate with Mr. Schmidt regarding this meeting, particularly with a view toward the organization of a local chapter in Philadelphia.

* * *

Mr. Schmidt will be glad to send to any member a revised copy of *A Method for the Photography of Gross, Wet or Fresh Specimens*. He also has a limited number of copies of *Practical Clinical Photography* by Lewis R. Wolberg, M.D., Kings Park, N. Y. Please send postage to Mr. Schmidt with your request.

* * *

The Rockefeller Institute for Medical Research and the Yellow Fever Commission of the International Health Board have recently prepared a large exhibit on virus diseases for the Convention of Public Health Officers, in New York. This display was made on translite film 40″ high and continuous with the length of the specially-built viewing cases. It is probably the largest single exhibit ever made on this type of film.

* * *

A recent paper, *Simultaneous Infra-red Roentgen Photography* by Leo C. Massopust, has been selected for publication in the *1937 Year Book of Radiology*.

* * *

The Pittsburgh Chapter held its first meeting of the season on October 6. A short program was planned so that opportunity was made available to the members to see the Salon photographs which had been exhibited at the annual meeting. The Salon was displayed in rooms adjoining the meeting room at the Falk Clinic. The

program consisted of reports on the annual meeting by Miss Shiras and Messrs. Levin and Henry. Afterward a film on *Ovulation in the Rabbit* was shown through the courtesy of the U. S. Department of Agriculture. Mr. J. Kenneth Doutt projected a film in Kodachrome of cattle-branding in the Southwest, which was made by him last summer. Mr. George Ryan showed two of his surgical films in Kodachrome, in addition to a motion picture showing some of the highlights of his hunt for diamond-back rattle snakes in the South. Some of the close-ups were uncomfortably good. The first Wednesday in every month is now Pittsburgh Chapter Night, with every other session a practical demonstration on negative- and print-making, mounting, lighting, etc., followed by general discussion.

* * *

The following members' papers have been recently published:

CLARKE, C. D. AND LOOPER, E. A.: A Survey of the Use of Motion Pictures in Medicine. *Urol. & Cutan. Rev.*, 41:715–720, Oct., 1937.

RICHARDS, O. AND RILEY, G. A.: The Growth of Amphibian Larvae Illustrated by Transformed Coördinates. *J. Exper. Zoöl.*, 77:159–167, Oct., 1937.

MASSOPUST, LEO C.: Photographic Images Obtained in Total Darkness by Both Penetration and Reflection of Infra-red Radiation. *Radiology*, 29:79–82, July, 1937.

* * *

The following papers should be of interest to many members engaged in infra-red photography:

RONCHESE, F.: Infra-red Photography in the Diagnosis of Vascular Tumors. *Am. J. Surg.*, 37:475–477, Sept., 1937.

WILSON, E. E.: The Changes in Infra-red Photographs Taken During the Treatment of Varicose Veins. *Am. J. Surg.*, 37:470–474, Sept., 1937.

* * *

Mr. William Payne read a paper on *The X-ray in Criminology* before the Western New York Society of X-ray Technicians, on October 16, at Rochester, N. Y.

* * *

The following new members are welcomed into the Association:

Adams, John F., 459 Washington St., Buffalo, N. Y.
Bowie, Eleazar R., M.D., 3503 Prytania St., New Orleans, La.
Bridgman, Charles F., 296 Glen Ellyn Way, Rochester, N. Y.
Claassen, H. L., M.D., 700 Provident Bank Bldg., Cincinnati, Ohio.
Comtois, Albert, M.D., 410 Sherbrooke West, Montreal, Canada
Dick, David W., McKesson & Robbins, Inc., Bridgeport, Conn.
Doutt, J. Kenneth, Carnegie Museum, Pittsburgh, Pa.
Duncan, Joseph, Sheboygan Clinic, Sheboygan, Wis.
Frank, John F., Jr., Jefferson Hospital, Philadelphia, Pa.
Edwards, C. V., M.D., 610 Bennett Bldg., Council Bluffs, Iowa.
Hart, Miss E. M., University Hospital, Cleveland, Ohio
Hayden, H. S., F.R.P.S., Montreal Neurological Inst., Montreal, Canada

Kastlin, George J., M.D., Skin & Cancer Hospital, Pittsburgh, Pa.
Kossack, Miss T. A., Queens Hospital, Honolulu, T. H.
Menlowe, Patterson, M.D., McKeesport Hospital, McKeesport, Pa.
Pearson, Miss Gertrude R., Child Research Council, 4200 E. 9th Avenue, Denver, Col.
Powers, Clarence C., 1214 S. Jefferson St., Springfield, Mo.
Pringle, Gordon F., Banting Institute, University of Toronto, Toronto, Canada
Seybolt, John F., 150 Crescent Rd., Longmeadow, Mass.
Siris, Irwin E., M.D., 1305 President St., Brooklyn, N. Y.
Vaden, Miss Evelyn, Children's Hospital, Philadelphia, Pa.
Wargalis, John J., American Mutual Liability Insurance Co., Boston, Mass.
Wellington, Hugo W. H., 31 Temple Street, Arlington, Mass.

Dr. George H. Semken, New York City; Carl W. Mueller, Easton Hospital, Easton, Pa.; George Ryan, Ryan Motion Pictures, Pittsburgh, Pa.; and the Fleischmann Laboratories of New York City have come into the Association as sustaining members.

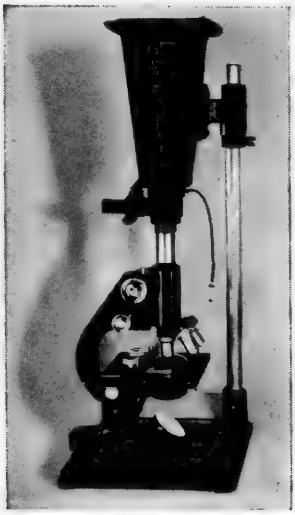
ARTHUR W. FUCHS
*343 State St.*
*Rochester, N. Y.*

# The Journal of the Biological Photographic Association

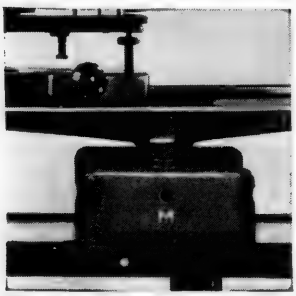
## *Contents*


The Airbrush and Its Use ..... *Carl D. Clarke* 101
Photography and Criminology ..... *Louis A. Waters* 124
Photographic Technic, New Processes and Equipment .. *F. R. Harding* 131
The President's Address ..... 136
Association News ..... 140


Index for Volume 5 will appear at the end of Volume 6



The Bausch & Lomb K Camera for making 3¼ x 4¼ routine Photomicrographs



The new enclosed shock absorbers which eliminate vibration in the B & L Large Photomicrograph Equipment

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# THE AIRBRUSH AND ITS USE*

CARL D. CLARKE

*Baltimore, Md.*

*Flexibility of the airbrush.* The airbrush is an instrument that makes it possible to combine paint with air in a spray. This spray may be applied as fine as a pen line or it will cover quickly and evenly a comparatively large surface. The brush proper is equipped with a cup or paint container that facilitates its use for a period of time without refilling. When properly used and controlled this instrument is flexible, diversified and speedy. It provides a great range and variety of textures (fig. 1). Such effects are accomplished by manipulation of a single lever which determines the amount of paint that flows from the brush and the texture it produces. Painting, drawing, stippling and blending can be accomplished with this brush. It also makes it possible to produce evenness of flat tones, gradations of shadows and shading, with less difficulty than many other methods. The airbrush is one of the most useful and important tools of the commercial artist, especially when used for the purpose of retouching photographs.

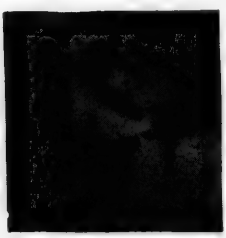
Not only is the airbrush employed for the retouching of photographs but also for making illustrations which are photographic in appearance. For example, an inventor or manufacturer may wish to make a change in a machine and have this change portrayed in a photographic manner before the change is actually completed. The retoucher can change the photograph of the original machine and incorporate the differences in the photograph. Quite often the retoucher is required to make an illustration of a piece of apparatus or a machine that is photographic in appearance. This can be done from a description of the plans or the blueprints of the subject in mind.

Medical illustrators will find the airbrush most useful in their daily routine work. The best of them find it indispensable for producing flat tones or even backgrounds, softly blended shadows and shading in color and wash. It is employed extensively in the production of drawings of eye grounds.

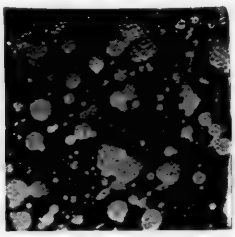
*The airbrush proper.* The airbrush is about twice the size of a lead

* From the Department of Art, School of Medicine, University of Maryland.

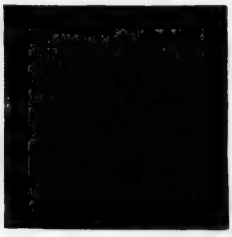
pencil and is held in the hand in the same manner (figs. 5 and 6). Its operation is regulated by the forefinger controlling a small lever which is in about the same place where the forefinger rests on a pencil in writing or drawing. This lever opens an air valve and allows the air to pass through the handle of the brush. A suction is thereby created in the color cup and as a result the color is mixed with the air. A needle situ-



Lace effect produced by spraying over lace.

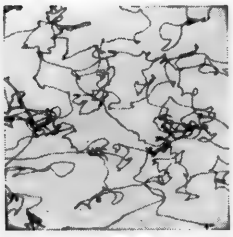


Snowflake or sleet effect produced by mixing rubber [cement with color used.]

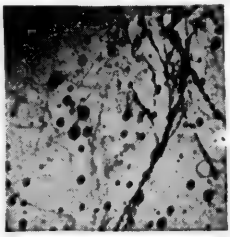


Open crackle effect produced by applying a heavy or wet spray of crackle lacquer.

Close grained crackle effect produced by applying a light coat of crackle lacquer.



Fine veiling effect produced very fast with Type UATR1 airbrush using veiling lacquer.



Combination veiling and stipple effect produced with Type UATF3 airbrush.

Relief effect produced with pressure cup Type UATR3 airbrush.

FIG. 1. POSSIBLE EFFECTS PRODUCED WITH AN AIRBRUSH
(Permission Paasche Airbrush Co.)

ated at the opening of the color cup moves rapidly back and forth and breaks up the paint into microscopic particles as it is mixed. The needle also controls the amount of paint that is mixed with the air.

*General directions for the use of the airbrush.* The Paasche Airbrush Company gives the following general directions for the use of its airbrush. The same directions may be applied to other makes of air-

brushes. First, from 30 to 40 pounds of clean, dry air pressure should be available. After the hose connections have been made there should be no leaks at the joints. The pressure is then turned on and the air hose blown out before being connected to the airbrush. This prevents

FIG. 2. PAASCHE SELFCENTERING MULTIPLEHEAD AIRBRUSH FOR ARTISTS, ILLUSTRATORS, RETOUCHERS, PHOTOGRAPHERS, AND DESIGNERS

Furnished in two types, MS and MMLS, which are the same except for difference in size.

(Permission of Paasche Airbrush Co.)

FIG. 3. TYPE A SHOWN IN OPERATING POSITION. TYPE B IN OPERATING POSITION

Easily converted into either position by changing the color spoon and air blast. (Permission Paasche Airbrush Co.)

dirt, particles of rubber, talc, etc., which may be in the hose, from being blown into the valve and clogging the air passage. The airbrush is held in the same position as a pencil or fountain pen, with the index finger resting comfortably, free and easy on the finger level control.

For fine work the airbrush should be held close to the paper. Then

press down on the lever so as to emit very little color. The volume of color is controlled by gradually pulling backward on the lever. When a greater volume of color is wanted or a larger spray desired, the airbrush is drawn away from the work and at the same time the finger lever is pulled back. Regulation of the line is effected by turning the eccentric disc in the front of the lever until a fine hair line is produced with the lever in a downward position.

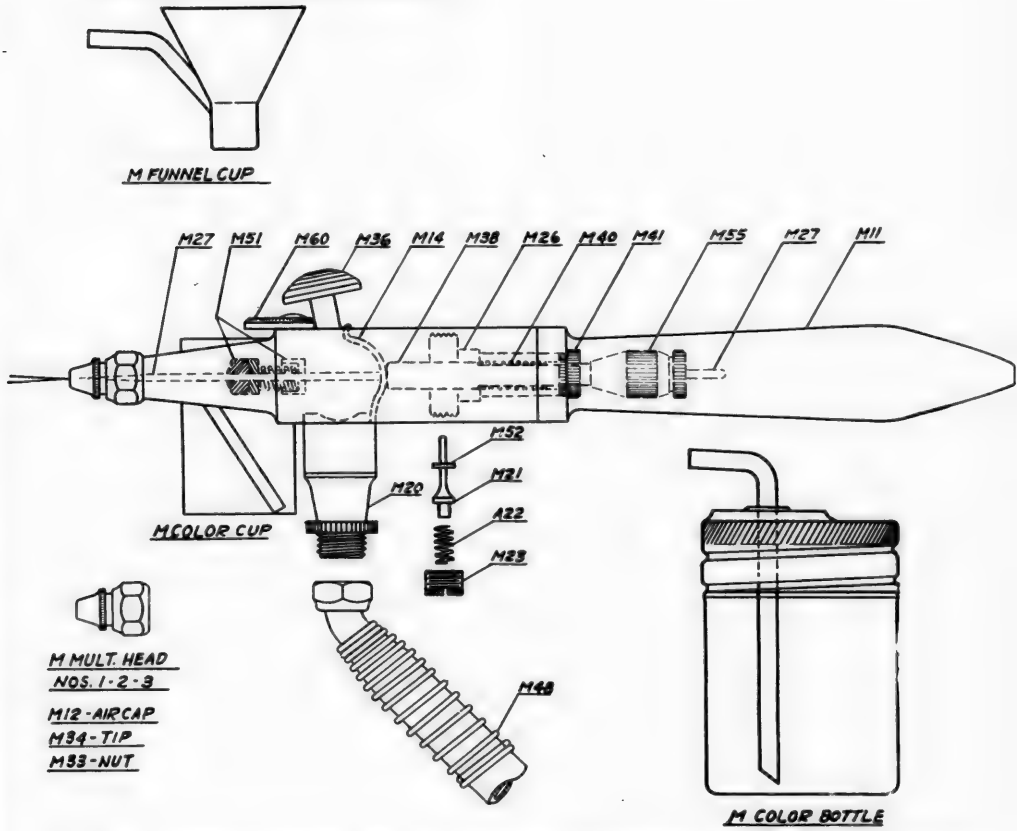



FIG. 4. DIAGRAM SHOWING THE MECHANICAL CONSTRUCTION OF A PAASCHE AIRBRUSH

The color cup is attached by placing the color cup stem in the color inlet of the brush with a forward push and twist which holds it securely in place. The cup is swung out from the body of the airbrush to leave ample room for the finger and to permit the last drop of color to flow out. If perfect results are not obtained immediately the blame should not be

FIG. 5. EASEL POSITION

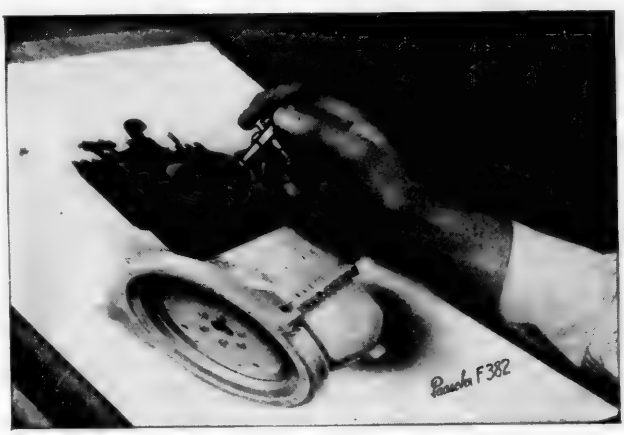


FIG. 6. DRAWING BOARD POSITION

placed on the brush. Its manipulation should be studied and as its operation becomes more familiar the desired results will be obtained. It is possible with the airbrush to produce from the sharpest hair line to a fine, smooth spray under easy control.

Color is important in getting the correct results and should not be too thin or too heavy. The proper consistency for trial work is about that of ordinary waterproof drawing inks. If a cheap color is used it is advisable to strain the pigment, as separate hard or undissolved particles frequently show up on the work and at times become lodged in the tip. This causes unevenness in the spray or total clogging of the brush. A good color is desirable and care must be used even with a good color so that it is thoroughly dissolved or entirely in solution.

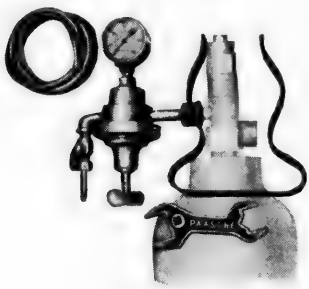


FIG. 7

FIG. 8

FIG. 7. CARBONIC GAS UNIT
(Permission Paasche Airbrush Co.)
FIG. 8. FOOT PUMP UNIT
(Permission Paasche Airbrush Co.)

Before putting the brush away clean thoroughly by drawing clear water or other solvents through the instrument.

If the airbrush should leak after the lever has been released, this indicates that dirt has worked into the valve seat and as a result the plunger will not seat properly. It is also possible that the rubber washer has deteriorated and needs replacing.

Results depend entirely on the knowledge and skill with which the airbrush is handled and in most cases where there are difficulties the operator is at fault. The best way to have the airbrush repaired is to mail it to the factory, where skilled and experienced workmen with proper tools will in a short time put the instrument back in perfect working condition.

*Air supply source.* The air for the airbrush proper is supplied from a liquid carbonic gas unit, a hand or foot pump unit, or an electric air compressor unit.

*Carbonic gas unit.* The carbonic gas unit is probably the most simple equipment and requires little attention (fig. 7). One tank of this gas will last for a considerable time, possibly three or four months in the average commercial art studio and longer in the studio of a medical illustrator or photographer. The tank should have a regulating valve which produces an even pressure that will not vary and a gauge that will show the amount of air pressure passing to the airbrush. Such a regulating gauge and valve should be on all units whether carbonic gas, manual or motor-driven.

*Hand or foot pump unit.* This unit consists of an air pump and an air tank (fig. 8). An air gauge is also incorporated to determine the amount of pressure that is being used. The artist possessing a mechanical turn of mind can construct such equipment at a cost of about five dollars, or one may be purchased for ten dollars. If he wishes to construct his own equipment he can purchase an air tank from a secondhand dealer or an ironmonger for about two dollars. The air gauge should cost one dollar and the air pump may be of the type that is used to inflate automobile tires by hand.

*Electric compressing unit.* The electric compressing unit is similar to that used by automobile filling stations to supply air for tires (figs. 9 and 10). While it is also possible for the artist who has some mechanical ability to construct his own electrical equipment, it is advisable to buy one that is already constructed as this unit embraces many technical points of physics and mechanics. If there is considerable airbrush work to be done the electric compressing unit will prove economical over a period of time.

Two added refinements are: a cutout valve which cuts off the motor when the desired pressure is reached in the tank and a regulating valve which supplies an even pressure while the unit is in use. However, these are not absolutely necessary as the safety valve may be set for the desired pressure (usually about thirty-five pounds) and the motor allowed to run during its use. In a unit of this type the continuous noise of escaping air is rather annoying. Therefore, an automatic cutoff switch and a regulating valve are valuable additions. Motor-driven pressure equipment may be purchased for twenty dollars and up.

*Pigments for the airbrush.* Water-soluble paint is used for wash drawings and retouching of photographs (fig. 11). The shades most frequently used are lamp black, Chinese white and brown ochre. The first two pigments are the same as those used for wash drawings. The third, brown ochre, is added to the other two merely to obtain a shade similar to the brownish cast of the average photographic print. If this were not used in the mixture of black and white, the retouched area would not be of the same shade as the photograph. On the contrary, the black and white alone would be gray with a bluish cast. This would mean

FIG. 9. ELECTRIC COMPRESSING UNIT
(Permission Paasche Airbrush Co.)

that the grays would appear lighter after photomechanical reproduction than they appeared to the eye on the original retouched photograph. The differences in color would also cause difficulty in matching the tones. However, these pigments may be purchased already mixed. They are supplied in various tones,—white, three or four shades of gray, and black. The brown ochre has been added to these shades.

*Retouching photographs.* In retouching photographs the artist improves the appearance of areas which the camera fails to fully portray. He can introduce supplements and cross section views in a photographic

technic. He can also eliminate undesirable features or add desirable bits of drawing. When necessary, blemishes on clinical or pathological photographs can be eliminated. Lesions pictured on these photographs can be enhanced to insure more perfect reproduction. However, when this is done no effort should be made to exaggerate or diminish the actual involvement of the disease as this would be a misrepresentation of medical facts. It is permissible to subdue certain portions or parts so that other portions or parts may receive the necessary attention. In this way unnecessary objects may be toned down or eliminated, thereby giving them their proper place in the scale of values and composition.

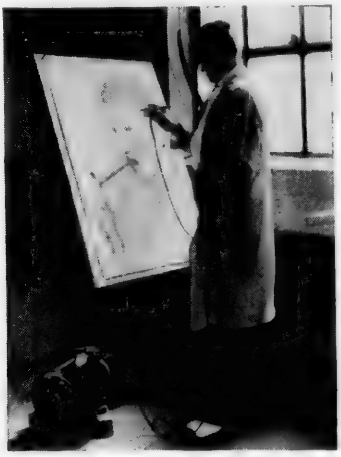


FIG. 10. SHOWING THE USE OF THE ELECTRIC COMPRESSING UNIT
(Permission Paasche Airbrush Co.)

It is here that composition in line and tone and profound training in aesthetic appreciation lift the work of the finished artist above that of the mediocre retoucher. This applies to scientific illustration as well as fine arts. Even if such drawings are technical and dry in their aspect, even if they are of repulsive and uninteresting subjects, they still may possess a great amount of feeling, beauty of technic and pleasantness in composition. Photoretouching, after all, is a process for the elimination, subduing or enhancing of parts, as requirements dictate, to improve the clearness and aesthetic beauty of the photograph as a scientific or pictorial illustration. With careful workmanship the most commonplace photograph can be made into a successful, dynamic picture for

reproductive purposes. If the retouched photograph is not intended for publication it may be rephotographed and the retouching becomes part of the second photograph, thereby becoming more durable.

*Mounting.* A number of years ago photographic prints were mounted by first soaking them in water, then applying water paste to the backs and placing them on the mount. They were then generally put under

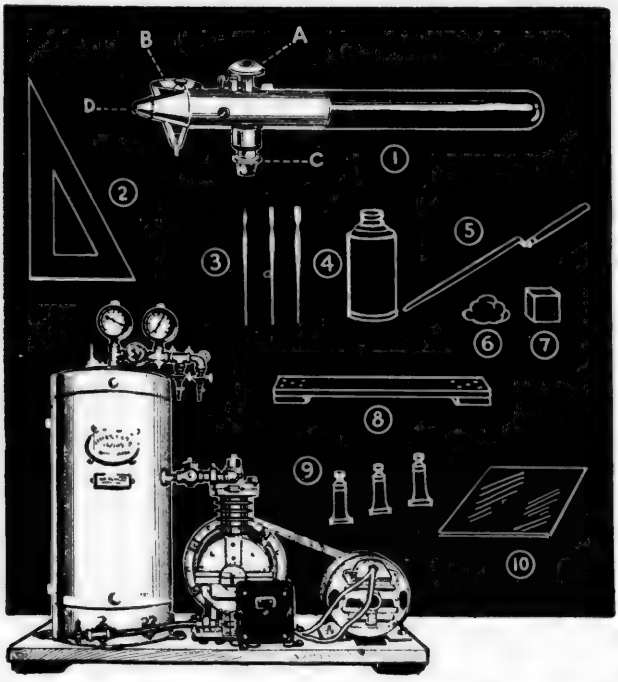



FIG. 11. COMPRESSING UNIT, AIRBRUSH, AND MATERIALS NECESSARY FOR DOING AIRBRUSH WORK

1. Airbrush. 2. Triangle. 3. Brushes. 4. Rubber cement. 5. Palatte knife. 6. Absorbent cotton. 7. Art gum eraser. 8. Arm support. 9. Pigments. 10. Piece of glass to serve as palatte.

pressure until entirely dry. A letter press or large squares of heavy glass were used for this purpose. If glass was used the prints were placed between two pieces to obtain the best contact. The drying of the water paste caused a warping or buckling of the prints and mounts, which added difficulties to retouching. This method soon gave way to modern drymounting with heat and prepared tissue or mounting with rubber

cement. The rubber cement method is less expensive and requires no costly equipment, and does not cause the prints and mounts to warp.

*Formula for making rubber cement.* Rubber cement may be purchased in all artist supply stores or it may be prepared in the following manner:

Dissolve one ounce of caoutchouc (Para rubber), which is raw, unvulcanized rubber, in a quart of benzine. This will take about three days to dissolve. If the mixture is too thick or too thin it can be thinned by adding more benzine or thickened by adding more caoutchouc. Rubber cement works most satisfactorily when it is of the consistency of thin syrup.

The author finds that this cement works well for his own purposes. However, *The Scientific American Cyclopedia of Formulas* gives the following formula among others, which is worth considering:

"Gutta-percha ..... 1 ounce
Caoutchouc ..... 2 ounces
Venice turpentine ..... 1 ounce
Carbon bisulphide ..... 8 ounces

Dissolve the gutta-percha and caoutchouc in the carbon bisulphide and add the Venice turpentine."

Frequently gums such as mastic and rosin are added; however, this may be left to the discretion of the experimenter as nearly every artist will find different requirements for his cement. With a little experimentation he should find a product to suit his purposes.

Figure 12 shows a method of mounting with rubber cement. Place the print, drawing or drawing paper face down on the mount to decide the position it is to take. Mark around the edges on the mount to permanently identify its position. Now pour a small amount of the rubber cement on the back of the print and spread it around with a palette knife, a wide brush or the finger tips. It is not necessary to be too careful in keeping the cement from running over the edges of the print and getting on the mount as it is easily removed. Spread a small amount of the cement on the mount within the pencil outlines. It is important to get plenty of cement on the corners of both the print and mount inside the pencil outlines.

After the cement on the print and mount has dried to a point where it is sticky to the touch, the print is placed in position on the mount. When the print is in place press its center with a soft cloth and rotate

the cloth in a circular motion as in scrubbing. This causes complete contact over the entire print. A squeegee roller such as is used in photography would also serve this purpose. The pressure supplied by the weight of the large squares of glass or a letter press helps to effect complete contact. If there is any cement on the surface of the print or the mount this can be removed by passing a cloth rapidly over the surface. The excess cement will roll up in small particles and leave the print and mount free of visible cement and with a clean surface. Should there be any cement left, as on the edges where the print joins the mount, it can be removed with a pointed eraser.

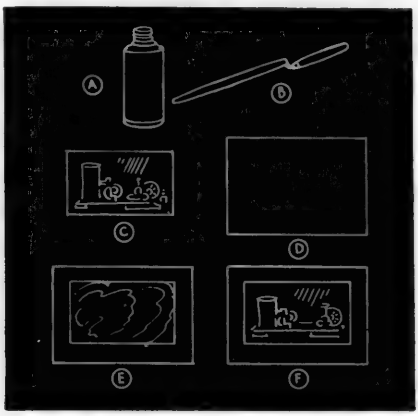



FIG. 12. METHOD OF MOUNTING WITH RUBBER CEMENT

A. Rubber cement. B. Palatte knife. C. Picture to be mounted. D. Mount. E. Rubber cement on surface of the mount, within the outlines of the picture. F. Print on mount.

*Methods of preparing the photograph for retouching.* Before actually applying the paint to the photograph with an airbrush or ordinary paint brush, the photograph should be mounted and prepared to receive the color. The mounting may be done with drymounting tissue or with rubber cement as described above. Some photographic prints have a glossy surface which is not well adapted to hold the paint. All prints, whether glossy or matte, collect a certain amount of grease from the hands. The glossy prints, as well as those with semimatte or matte surfaces, may be prepared for the paint by briskly rubbing the entire surface with an art gum eraser. Alcohol or ether may also be used for this purpose. One of the best chemicals to use for removing grease from

any surface is magnesium oxide. A block of this material may be purchased in most drug stores for ten or fifteen cents. The block may be rubbed on the print in the same way as an eraser, or it may be powdered on and then rubbed around with a dry cloth.

Another method of preparing a photograph for retouching is as follows:

Moisten a piece of cotton with a 10 per cent solution of acetic acid and rub it lightly over the entire photograph.

Many artists moisten a wad of cotton with their own saliva for this purpose. This is not only an unsanitary method but one that cannot be recommended to medical illustrators. In drawing from fresh pathologi-

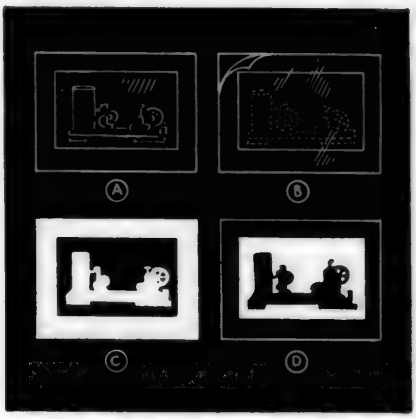



FIG. 13. METHOD OF PREPARING FRISKET PAPER MASKS

A. Picture on mount. B. Frisket paper over photograph. C. Frisket paper cut away for retouching background with airbrush. D. Frisket mask removed after background has been made white.

cal specimens there is a possibility of infecting one's own mouth. Therefore, in this particular work it is a good rule to put nothing into the mouth or to the lips that does not belong there.

*Frisket paper.* For airbrush work it is necessary to provide some means of masking out parts of the drawing or photograph while using the airbrush on other parts. This can be done with ordinary paper masks or with tracing paper, but a prepared paper called *frisket paper* is far better for this purpose (fig. 13). Frisket paper is transparent tissue paper that lies flat on the drawing or photograph to be retouched. This paper makes it possible to see the drawing beneath its transparent

surface and assures the artist that his paint will not reach the surfaces covered by the paper. It may be applied over the entire surface of the drawing and the parts to be retouched with the airbrush may be cut out with a *frisket knife*, an ordinary knife or a razor blade. Care must be taken, however, to avoid too much pressure on the knife as this would cause it to cut through the frisket paper and into the drawing or photographic print below. Soon the artist learns to use the exact pressure needed to cut through the frisket paper without damage to the drawing or photograph beneath. The sections which have been cut out are then removed. After the airbrush work is completed the remaining parts of the frisket paper are removed. Since the adhesive used in preparing this paper is rubber cement, there is a possibility that a few particles of the rubber will be left on the drawing surface. These may be removed by gentle friction of the clean finger tips, an art gum eraser, a soft cloth or a wad of cotton. Of course, this should not be done until the paint is thoroughly dry. The tissue paper that is used to separate each sheet of Eastman drymounting tissue serves excellently as frisket paper.

After the airbrush work has been completed the drawing or retouched photograph is enhanced by further work with ordinary brushes and the wash pigments, pen and ink, and dry brushes used with crayon sauce.

*Preparation of frisket paper.* Frisket paper can be prepared with adhesive for application to the drawing in the following way:

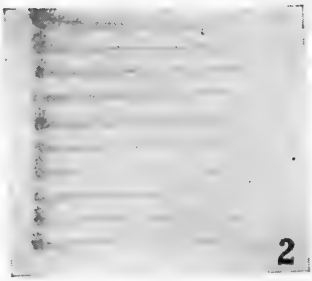
Each corner on one side of the frisket paper is touched with a small dab of rubber cement. These corners are fastened to a piece of cardboard so that the paper lies flat. A two-inch soft brush dipped in a dilute solution of rubber cement is brushed quickly over the paper in long strokes. This is allowed to dry for about fifteen minutes and then brushed over again. Too much pressure on the brush will cause the first coat to start rolling up in small particles. When the paper is dry it is ready for future use and should not be allowed to come in contact with anything else as the two surfaces will readily stick together. The paper should be left on the cardboard until it is needed. It is then detached by passing a knife between the corners of the frisket paper and the mount. The adhesive side is placed in contact with the drawing or photograph and the portions to be retouched are cut away.

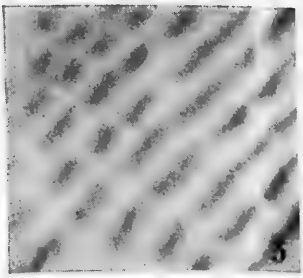
*Beginning the work on a photograph.* The photograph is now ready for retouching. Before the paint is applied to the surface a small amount of the pigment is prepared in a mixing pan or on a glass palette. This

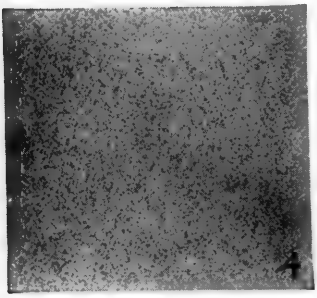
should be of the exact tone to match the photograph and for this reason the correct amount of brown ochre should always be added. It is not advisable to work over a part of the photograph when unnecessary; only the part that needs improving should be retouched. The pigment should be handled in a fairly thin state and at the same time be thick enough to cover undesirable blemishes. This primary work is done with ordinary brushes in order to become acquainted with the tones. Matching the color or shade of the print should be practiced and more brown ochre added when necessary.

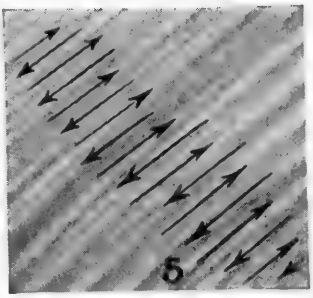
*Using the airbrush.* After practice in matching tones it is time to fill the cup of the airbrush. Before actually using the instrument on the photograph it is advisable to practice with it on an ordinary piece of paper until its use and action is thoroughly understood. It is used somewhat differently than an ordinary brush or pencil. When using brushes and pencils the fingers come more into play as strokes are made by moving the fingers backward and forward. In using the airbrush the fingers are held stiff, the principal movements being made by the muscles of the forearm swinging from the elbow, with a movement from side to side. Pressure on the control lever is exerted only when the arm is in motion, otherwise there will be a heaviness of pigment at the start of each stroke. (See *Explanations of airbrushing effects* in figure 14.) It is good practice to exert pressure on the control lever when the point of the brush is a slight distance from the photograph or drawing; as the spray begins to flow the point is brought closer to the surface. Here it is necessary to avoid pulling too far back on the control lever while the brush nears the paper, as the amount of paint leaving the brush will greatly increase. Whenever pressure is exerted on the control lever the brush should be in action. When detail work is to be accomplished with the airbrush, the lever is seldom pulled back to any great extent. Pressure is exerted on the lever only. However, if the needle is not regulated to cause a flow at this point, it may be pulled back until the flow begins and then the lever is held stationary.

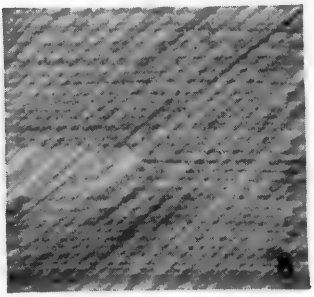
*Improving the background in the picture.* Quite often it is necessary to take photographs under adverse conditions. Such photographs contain unnecessary objects in the background which detract from the subjects to be shown. There are four ways of removing such objects. The first is by opaquing or painting the background on the negative with red or black opaque water color. When the negative is printed this leaves the background on the print pure white.

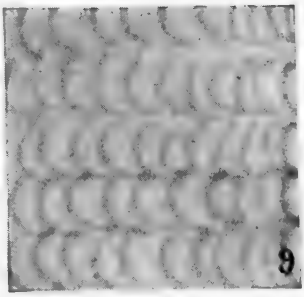


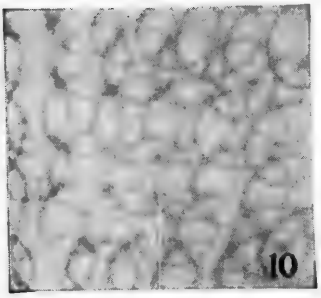



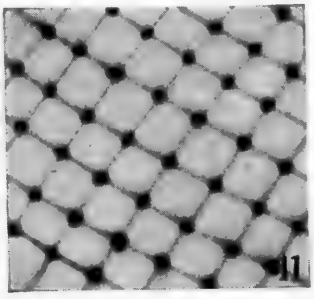



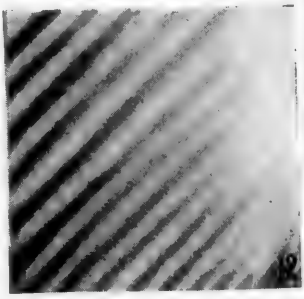





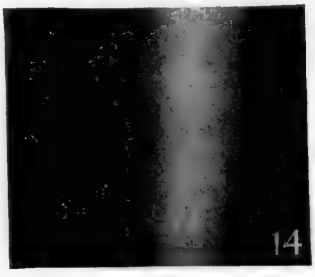


FIG. 14

The second method is to paint out the background on the *print* with a fairly large brush and white opaque water color.

In the third method frisket paper is placed over the entire print and the portion that covers the background that is to be removed is then cut away. The edges of the frisket paper which remains should adhere firmly to the print. Dampen the print with a piece of cotton that has been saturated with a solution of sodium cyanide and tincture of iodide until the background is bleached out. Do not rub the print with this solution. Wash the print thoroughly and remove the frisket paper. If airbrush work is to be done on the background the frisket paper should be replaced after washing. Ferricyanide and hyposulphite of soda may also be used for the purpose of bleaching out the background.

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FIG. 14. EXPLANATIONS OF AIRBRUSHING EFFECTS

1. Result of pulling the finger lever back too far and holding the airbrush too close to the copy.
2. Pressing the lever while the arm is not in motion. A dot at the start of the line is the natural result.
3. Airbrush working in spurts, because it is not perfectly clean and the color is too thick. A split tip or leakage of air in the joint where head is coupled will also produce similar results or air will bubble back through color cup.
4. Airbrush needle is bent at the point which causes the spray to spatter. With a reduced air pressure most any shade of stipple can be made. Do not operate the finger lever if the needle point is bent. This will split the tip—straighten tip carefully, then remove needle for repointing.
5. Spray with the airbrush finger lever pressed down and the brush about one inch from copy. Arrows point to the direction of the stroke.
6. A tint with transparent color, holding the airbrush about five or six inches from the copy. Using the color thin and swinging the arm backward and forward as indicated in No. 5. Spray a light tone over the entire surface and continue with the same spray of color, refilling the cup if necessary, until the exact tone wanted is on the copy.
7. With the color thin put a light spray over the entire surface with the exception of the lower corner. Continue with this thin color, graduating the color to a darker tone towards the top by air-brushing until the darkest tone can be had with the color that is in the color cup. Then refill the cup with real dark color (a greater amount of black in the water) and airbrush the blackest corner.
8. A practice lesson in airbrushing lines.
9. A practice lesson in curves.
10. A practice lesson in circles.
11. A practice lesson in lines and dots. In making the dots, touch the lever very lightly without pulling the lever back.
12. With the lever pushed down and pulled back, reduce the tint, the movement being from you.
13. Good effects can be had on negatives as well as photo prints, by the use of unevenly torn paper held on the copy and airbrushing on the edge of the paper. Hold the brush at least an inch from your copy.
14. A practice lesson for curved subjects such as cylinders and machinery.
15. Airbrushing portraits.

These are only a few rough effects produced by beginners. Unlimited possibilities are in store for the student that becomes professional with the airbrush process.

(Permission of Paasche Airbrush Co.)

The fourth method includes removal of the background on the print by means of the airbrush, frisket paper and opaque water color. In all of these methods the composition of the picture may often be improved by extending or reducing the boundary lines.

The author believes the fourth method mentioned to be the most satisfactory. The first is undesirable because many negatives are so small that it becomes quite impossible to work in their cramped space. The disadvantage of the second method lies in the fact that the brush strokes are very likely to show after reproduction even if an enlargement of a small negative is painted over with an ordinary brush. This fault may be eliminated with the airbrush. The third method is satisfactory if carefully done and if the edges of the frisket paper stick closely to the print. However, this method leaves a pure white background unless it is touched up with the airbrush.

A description of the method of removing backgrounds from a photograph print with the airbrush is as follows. Incidentally, this method may be combined with any of the other methods for shaded backgrounds after the unnecessary objects in the background have been painted or bleached out. The entire print is covered with frisket paper and the paper that covers the part of the print to be removed is then cut away. The knife should be sharp to prevent ragged edges on the frisket paper. The edges of the subject that is to remain are cut very closely and care should be taken to avoid running over the edges in any direction. If this should happen the edges may be blended in with the rest of the picture with an ordinary brush after the frisket paper has been removed.

The color cup of the airbrush is then filled with white opaque paint and the undesirable background is painted over. After the background has been painted out with white, a dark shade of paint may be placed in the color cup and a blended or diffused background drawn. In the same manner shadows from objects can be drawn in the background to enhance the pseudostereoscopic effect of the picture.

*Obtaining tones and gradations of tones.* The photograph of a cylinder, such as the section of a shiny pipe, may be used as an example of an object that is to be retouched. Frisket paper may be placed over the entire photograph and the section covering the cylinder removed. An ordinary brush is dipped into the white paint and a drop or so is put in the cup of the airbrush. The instrument is then used to put the high lights on the cylinder. To prevent this tone from spreading, the part

of the cylinder which is outside the bounds of the high light is covered with a thin, square piece of cardboard. The airbrush is then loaded with a slightly gray tone, the high light is covered with the thin cardboard and the next tone is painted in. After this is done a still darker paint is

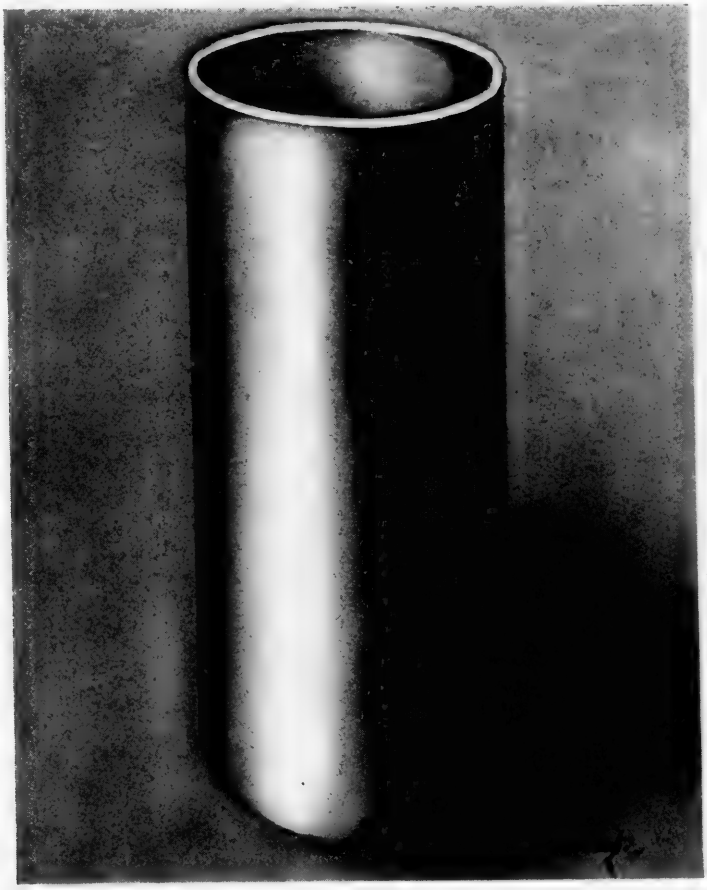

FIG. 15

used in the airbrush and the next darker tone is put in, and this process is continued until the various tones of the cylinder are painted. In this particular case tones are very apt to be separated by a sharp line or a thin area of tones that impinge on each other. This differentiation between tones is accomplished by placing the thin piece of cardboard or

a strip of frisket paper over one area while painting another. The square of thin cardboard may be held in the left hand with its edge covering part of the cylinder while using the airbrush in the right hand. The cardboard must be held steady in order to obtain a sharp line, otherwise a broken and diffused line is likely to occur.

*Painting out the background and finishing.* After the entire cylinder has been satisfactorily executed the frisket paper may be removed from

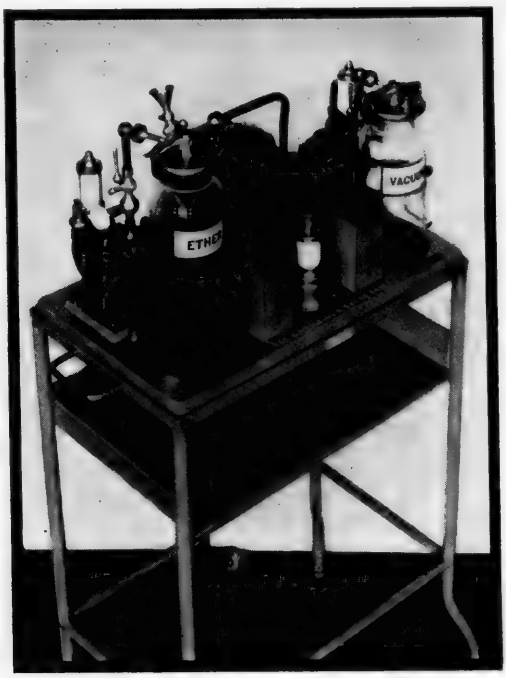


FIG. 16. AN UNRETOUCHED PHOTOGRAPH

the background. A second piece of frisket paper is placed over the cylinder only. The background and shadow are then painted. When this has been carefully done the frisket paper is removed from the cylinder and the entire drawing is finished with ordinary brushes and the same tones that were used to load the airbrush. These ordinary brushes are used to "pull the drawing together," which consists of smoothing out or sharpening edges and adding sharp high lights where necessary. Ordinary pens, ruling pens, and white, gray or black ink may be used to good advantage, especially in the ellipse at one end of the cylinder. However, it is necessary to prevent the use of too many sharp, unblended

lines. Pencil dust applied with a dry brush or carbon pencil lines that are softened with a pointed cork may also be used over the water paint after it is thoroughly dry. The black pencil dust may not match the tone exactly since it contains no brown ochre, but it may be used in rare cases to snap up a drawing when necessary. It is advisable to avoid this procedure if possible.

FIG. 17. SAME PHOTOGRAPH AS SEEN IN FIGURE 16 AFTER RETOUCHING

Mr. James R. Howard, Jr. wrote an interesting article for the *Journal of the Biological Photographic Association*[1] in which he described his method of retouching photographs. The author is indebted to Mr. Howard for excerpts included in the following technic.

*Retouching a more complicated subject.* The unretouched photograph shown in figure 16 should be considered. The problem here is to bring

[1] The Art of Photoretouching. *Jour. Biol. Photo. Asso.*, Vol. 1, No. 3, 1933.

out the commercial value by enhancing certain technical points or areas in a graphic manner. Before mounting on white cardboard the print was cropped or cut down to the close-up view seen on the right in figure 17. This close-up view has a tendency to bring the observer into the picture and gives the artist a chance to point out or make more prominent the technical advantages of the subject that the picture portrays.

Frisket paper was used over the machine when the backrgound was drawn in. In this case the background was darkened to accentuate the machine. After the dark background was redrawn the frisket paper was removed from over the machine. Another sheet was placed over the entire photograph and cut out so that the pieces which covered the parts of the machine could be removed. The airbrush was then used to apply paint in the proper tones to the places from which the frisket paper had been removed. Parts having the same tone could be removed at the same time. There was considerable blending on the stand which was executed with the airbrush. The metal tube that is connected to the ether jar was straightened. All such parts were drawn by using various shades of wash in a ruling pen. High lights and details were added with an ordinary brush after the airbrush work was completed. The sharp white lines which outline the base and uprights were drawn with a ruling pen filled with white ink.

In comparing these two pictures, before and after retouching, it should be noted that the reflections in the ether jar have been removed and high lights added to take their place. The container in which this jar sits has been simplified and rounded. Portions of the jar itself have been subordinated and others emphasized. While there is a great contrast between the retouched and unretouched photographs, the former still possesses a photographic appearance.

The lettering in the retouched photograph was the last thing to be applied and was done over a gray background. The arrows were made in black and outlined in white to give contrast. This was made possible by the two tones of gray in the background.

Of course, as in other art work the airbrush drawing may be erased to a certain extent. In case the drawing over the photograph seems to be a complete failure, all of the paint may be removed with a piece of absorbent cotton dampened with water. The photograph will then be ready for retouching again.

The same instructions which have been given for retouching photographs may be applied to the making of drawings with the airbrush or to enhancing the beauty and reproductive qualities of pictures made

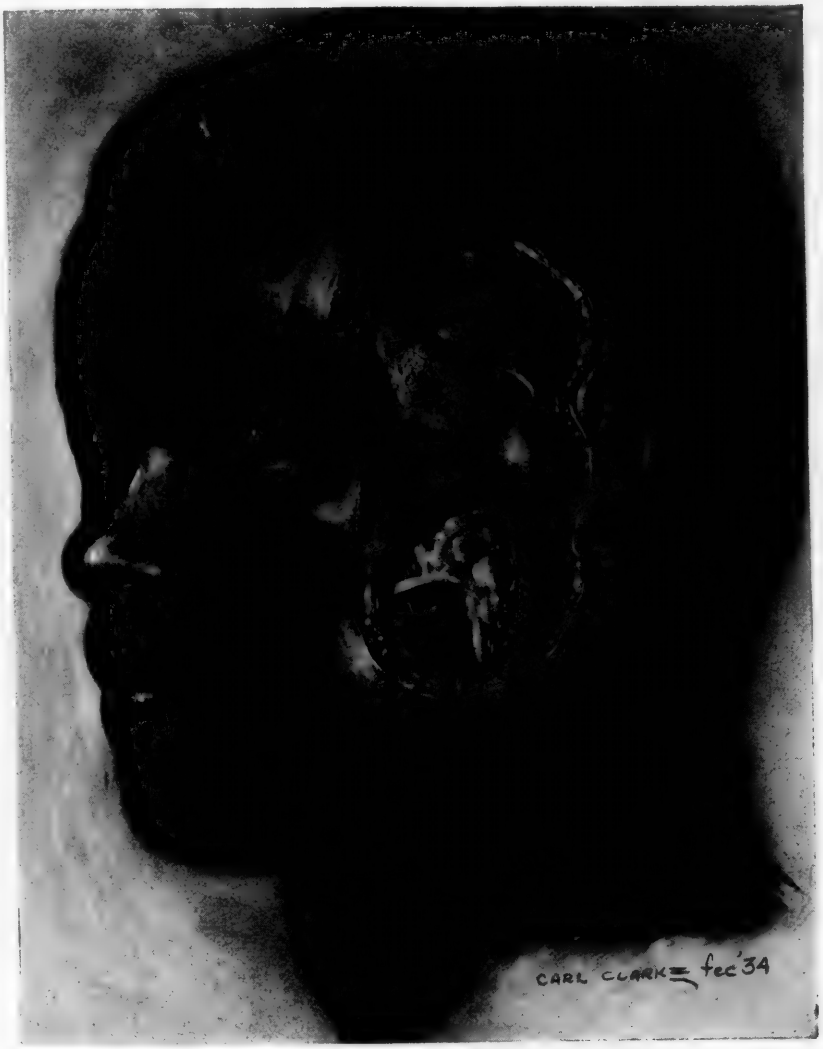


FIG. 18. A TYPICAL MEDICAL DRAWING IN WHICH THE AIRBRUSH WAS USED
This picture was drawn in the crayon sauce technic from a photograph of the patient before any surgical procedures were begun. The airbrush was used to obtain the blacks and to blend evenly some of the half tones.

in some other medium of expression, such as wash and the crayon sauce technic. The airbrush plays an important part in the making of good medical illustrations and is used on such subjects in the manner described.

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## PHOTOGRAPHY AND CRIMINOLOGY*

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Conviction of the criminal depends on presentation of the proper evidence in correct arrangement to the court and jury. Much of the most important evidence is circumstantial and, by its nature, easily destroyed. For some time the use of photography as a means of preserving this type of evidence and presenting it to the court has been increasing. It is safe to say that today every good-sized city police force employs a photographer.

For nearly twenty years the author has been employed by a district attorney and by various other attorneys to investigate crimes, such as murder, arson, forgery and fatal accidents, and to preserve such evidence as may be discovered by means of photography. Photomicrography, infra-red, ultraviolet, and most other types of photography have been employed. It will perhaps be easier to show what has been done by briefly reviewing a few actual cases. In some cases the names have been deleted, but these will be supplied to anyone interested in studying the cases more fully.

In Buffalo, some years ago, a woman was accused of murder in the first degree. It was claimed that she had deliberately shot her husband. There was no dispute that he had abused her and threatened her all evening, but the prosecution claimed that she had entered the house and secured a revolver, then stepped out on the little screened-in porch and deliberately fired at her husband as he was standing outside on the front lawn.

She claimed that they had both entered the house and that he had grabbed the gun from a drawer. She grappled with him in self-defense. They wrestled through the house and across the front porch. When

* Read at the 1937 Convention of the Biological Photographic Association.

they reached the front steps he stumbled on the top step and released his grip on the gun. Both continued out onto the lawn, where he recovered his footing and rushed at her. Without realizing that she held the gun she raised her hands to protect herself, the gun was discharged and killed him.

Permission was secured to examine the fatal bullet, which, the doctor who recovered it claimed had lodged just under the skin of the back and which had hit no bones. The nose of this bullet, greatly magnified, is shown in the photograph (fig. 1 b). The same kind of gun that was used in the shooting and a quantity of the same ammunition from the lot that had produced the fatal bullet was then secured. More than two hundred rounds were fired through a screen of the same type and weight as that which had screened the porch. The bullets were all caught in cotton waste after passing through the screen. Some of the bullets were fired so that they went through an inch of solid oak plank after passing through the screen. Then the noses of all the bullets were examined and on each and every nose there appeared a pattern of the screen wire like that shown in the picture (fig. 1 a). This particular bullet is one which had gone through the oak plank after having passed through the screen.

The absence of the marks of the screen on the fatal bullet and their presence on all of the test bullets served to convince the jury that the wife was telling the truth and she was acquitted of the murder charge.

There was also the incident of the railroad policeman who was charged with murder in the death of a Polish boy whom he saw stealing coal. The officer claimed that he had fired at the ground when the boy started to run away and hoped in this way to frighten him so that he would stop, but that the bullet had ricocheted on the frozen ties, glanced upward and hit the boy in the back. The ballistics expert of the local police asserted that this was not true since the doctor who performed the autopsy reported that the bullet had entered the body point first. The police expert stated further that any bullet which ricocheted always "keyholed" or entered sideways.

Here again a series of experimental shots were fired. This time a series of thin wooden screens was set up perpendicular to the floor. Between each screen and the next one was the space of an inch. Some railroad ties were laid on the floor. The gun was fired from various distances in

such a manner that the bullet hit the ties at an angle, glanced off and passed through the wooden screens until it was spent. The photographs of portions of the screens show a few of the test results. It was learned

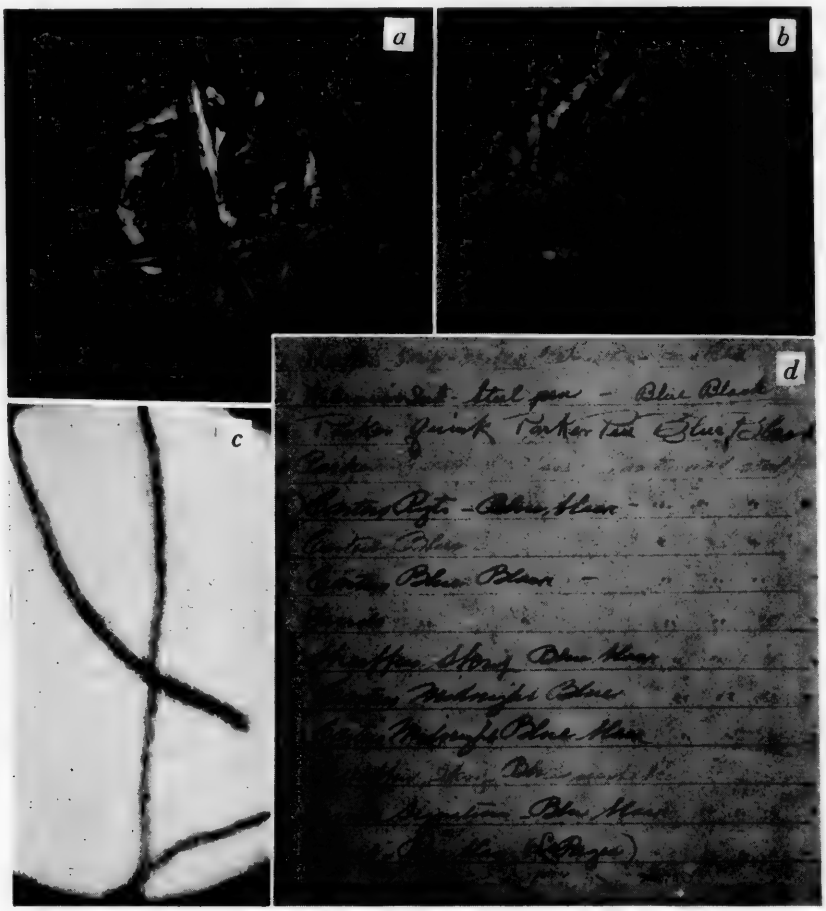


FIG. 1

*a*. Nose of bullet fired through screen
*b*. Nose of fatal bullet
*c*. Photomicrograph of part of "J"
*d*. Infra-red photo of ink chart

that the ricocheting bullets might enter the first screen in three positions, viz., point first, base first and sideways, according to the angle at which they glanced from the ties and the distance from the point of impact on

the ties to the screen. These tests convinced the jury that the policeman was telling the truth and he was acquitted. Picture of the test bullets are shown in figures 2 a and b.

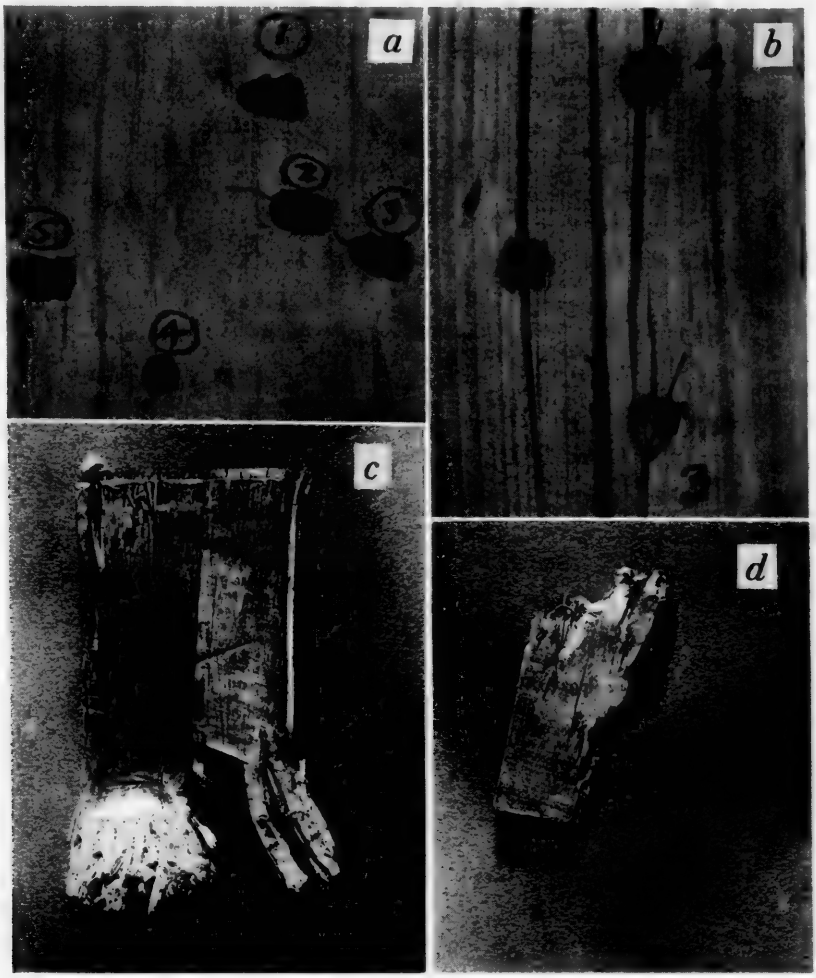


FIG. 2

*a*. 1, 2, 3 and 5. Bullets entered sideways. 4. Bullet entered base first.
*b*. 1. Bullet entered point first. 3 and 4. Entered point first slanting upwards.
*c and d*. Fragments of bomb showing reversed print.

Perhaps some of the readers may feel that the rôle of securing evidence to convict criminals is violated by the report of these two cases which

provided evidence to acquit two accused persons. However, it is the rôle of science to secure true justice by revealing the truth. If innocent persons are charged with crime it is the duty of the scientific investigator to discover the facts and secure their release, just as much as it is his duty to try to secure the conviction of those who are condemned by the facts.

A wealthy man called his two sons and his daughter to him and in their sight endorsed over to them certain stock certificates. He then placed these in his safe and told the children that after he died they should take them. The daughter was married shortly afterward and the father died later. When she went to claim her stock, the brother who occupied the office denied that the father had ever signed the transfer to the daughter. She insisted upon seeing the certificates and it was discovered that the one which should have been transferred to her was blank. She secured an attorney and he obtained an order to have an expert examine the share of stock. By oblique light it could be seen that there had been an erasure, but it was impossible to figure out what had been written.

The certificate was brought to the author and he used infra-red light to photograph it. The two pictures reproduced here show a part of the share of stock as it appeared to the eye and to the ordinary photographic emulsion, while the other view reveals what the infra-red brought out (figs. 3 a and b). The brother's attorney was shown the picture and the defendant at once settled the case.

A woman was killed by the explosion of a package which was left at her rooming house for her. Careful exploration of the wreckage brought to light many fragments of the wooden box which had held the explosive. These pieces were smudged and blackened, but photographs of the pieces with infra-red brought out the printing, in reverse, of the newspaper in which the bomb had been wrapped (figs. 2 c and d). Piecing the photographs of the lettering together in the manner of a jig-saw puzzle revealed enough of the printing to prove that the paper was a particular edition which was sold only in a certain locality. From the date of the paper it was evident that the bomb was wrapped in it shortly after the paper had been published. This served to tie the bomb with a locality where one of the suspected persons lived and greatly aided the investigation of the case.

In the matter of the comparison of handwriting in forgery cases, there is no better method of showing to the court the various points of simi-

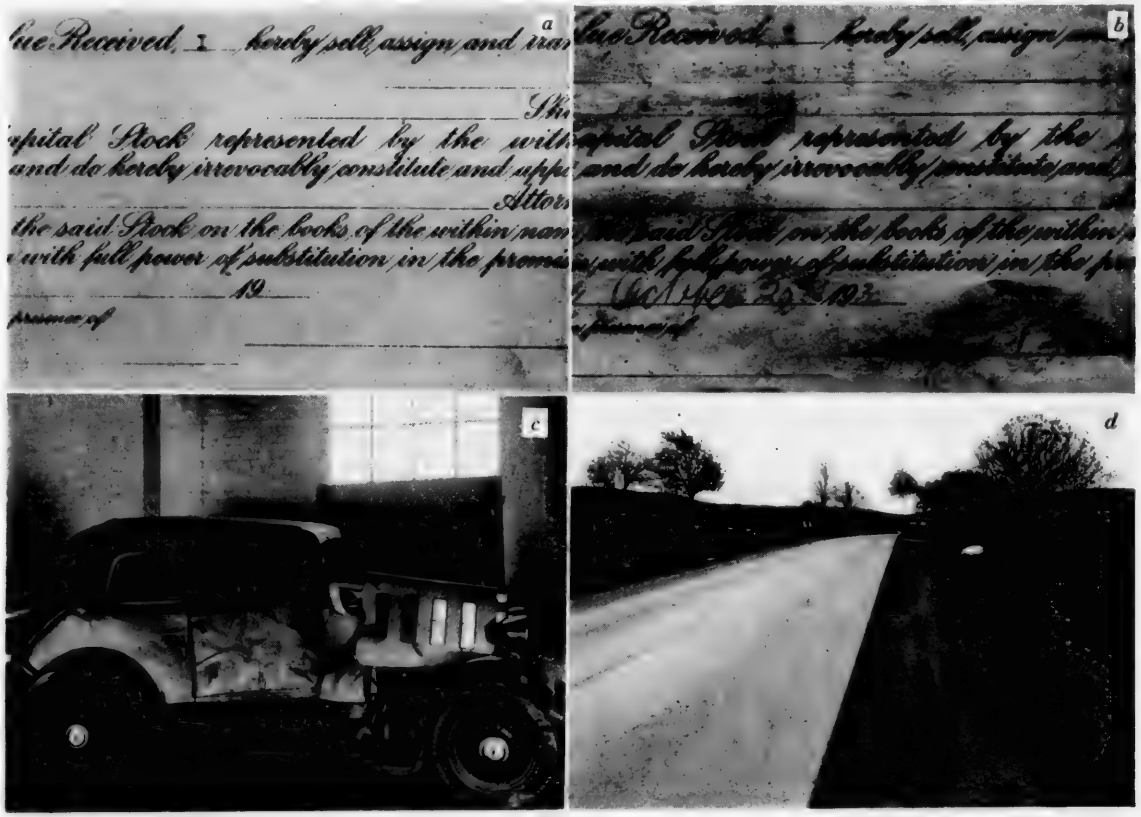


FIG. 3

*a*. Certificate photographed on panchromatic film
*b*. Same photographed on IR plate with 87 filter
*c*. Side of car showing headlight imprint
*d*. Skid marks on highway prove car on wrong side

larity or difference than by means of enlargements of the various signatures or other writing.

Photomicrographs are also of use in handwriting matters. The illustration of the portion of the letter J was used to prove a forgery. The signature was forged by tracing with a pencil. The forger traced it from right to left, however, and this caused all crossing lines to have the wrong line on top. The J shows that the initial stroke is on top of the long vertical stroke of the letter, but if the letter had been written in a normal manner the initial stroke would have been beneath the other (fig. 1 c). This was true of the intersection of all strokes in the name. Since the man's admitted signatures showed that he wrote from left to right, as most people do, it was apparent that he had not written this signature. Since the writer in this case was dead, only the circumstantial evidence was available to secure a conviction.

While on the subject of handwriting it may be of interest to note the different reflections of various inks when photographed by infra-red light. The chart shown was written in the various inks indicated. These inks were dark enough so that when the writing was photographed on an ordinary plate there was almost no difference in the distinctness of the words. In the infra-red picture some of the inks show very faintly and indicate almost complete reflection of the rays, while others are almost black and show that they absorb nearly all of the infra-red. The watermark in the paper is also clearly visible (fig. 1 d).

At most it is barely possible to skim the surface of the subject, which accounts for the lack of continuity in this paper. There are several additional phases worthy of mention where the use of photography is of importance in convicting the criminal or freeing the innocent. The view of a car shown herewith gives a clear imprint of a headlight rim in the door on the right side of the car. The driver of this car was killed, but the driver of the other car claimed that the dead man was at fault and that he had not hit the car in the side. He said the damage had been done when the death car crashed into a pole in trying to avoid his car after cutting in front of him. His car was a heavy one and only slightly damaged, but the left front light was broken and the rim was of the same diameter as the imprint on the door of the light car. Moreover, it was at the same height from the ground as this mark. He was not convicted in the criminal action but the jury in the civil case brought in a verdict against him (fig. 3 c).

The picture of the road scene (fig. 3 d) shows a skid mark on the highway. The driver of the car which made the mark was coming toward the observer. The mark shows that the driver swerved his car to the wrong side of the road, where he struck and killed a boy who was walking on the shoulder. The measurement of the length of such marks, together with a consideration of the type of road surface and its condition (dry or wet), the weight of the car and the condition of the tires will give a skilled investigator an excellent idea of the rate of speed at which the car was moving when the brakes were applied. This testimony is not admissible in court since the variable factors are too many to permit sufficient accuracy, but they do provide a means of judging whether or not the driver and witnesses of the accident are telling the truth.

There are, of course, many other uses for photography in police work but in the limited space available it is impossible to cover the entire field. Suffice to say that careful and serious workers will use photography in one form or another to preserve and present evidence whenever there is a likelihood that such evidence may otherwise be lost or overlooked.

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## PHOTOGRAPHIC TECHNIC, NEW PROCESSES AND EQUIPMENT*†

F. R. HARDING

*Boston, Mass.*

### THE LIGHTING AND POSING OF CLINICAL PHOTOGRAPHS

Clinical photography has progressed a long way since the days when all patients were photographed in a flat light. Today it is unusual for two patients in succession to be placed in the same combination of lights if the best results are to be achieved. Surgical and orthopedic cases account for a large number of the patients passing through a busy hospital photographic department. A description of the methods of lighting and posing of many of the more common types of surgical and orthopedic cases handled at the Children's Hospital in Boston may be of assistance to those individuals who do only a small amount of this type of photography. This posing and lighting has been employed on children but it is equally effective on adults.

The purely mechanical operation of the camera may be mastered over a comparatively short period, but much time must be spent in the mastery of light (1). Without this knowledge the best results cannot be attained. The subject of light has been

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* From the Department of Photography, Children's Hospital.

† Received for publication January 15, 1938.

discussed in this department before, but its mastery cannot be stressed too often as it is upon this point that many photographers fail.

The writer prefers clear glass 1000-watt lamps above all other sources of light. Clear glass lamps produce harder shadows and appear to bring out more contrast and modeling than the softer light from frosted lamps. This is the writer's opinion; there are many who differ on the subject.

The only way to learn how to employ light is to experiment with various settings of the lights in relation to the patient. The writer prefers to use the lights about three-and-one-half feet from the patient, irrespective of the distance from the patient to the camera or the distance of the lights from each side of the camera. This distance, or whatever distance is chosen, must be maintained within close limits in order that a standard exposure may be employed. The light should usually fall down on the patient, although there are exceptions to this rule. Unless this is done the modeling will be poor, as illustrated by the lack of modeling seen in photographs which are made with a synchronized photoflash fixed to the side of a press camera. This is complete flat lighting. In other words, the light is practically at the level of the lens and produces a minimum of modeling. Lateral lighting has been described previously (2) and will not be discussed further at this time. To employ normal lighting one light must be placed about twelve inches farther away from the patient than the other. However, this is not a hard and fast rule and the photographer should use judgment in placing the lights. Pockets of shadow around the neck and under the chin should be avoided. If necessary, one of the lights should be lowered sufficiently to break up these shadows. Care must be taken to prevent overbalancing of the picture by heavy shadows on one side of the patient. This is caused by having one light too far away from the patient. It should be remembered that the eye and the photographic emulsion do not see shadows with the same intensity, especially in artificial light. The far light should be brought toward the patient until the shadow seems thin or light to the eye. The photographic emulsion will increase the contrast. There should always be a permanent light of about 500-watts affixed to the top of the background to model the top of the head in standing or sitting figures. If this is not used the hair will probably blend off into the background and at times the shape of the skull will be lost.

*Orthopedic subjects.* Most foot and lower leg subjects require similar forms of lighting, thus cavus, calcaneo, valgus, varus and club feet require practically the same treatment by the photographer. The light should be at or slightly above the knees and directed down toward the feet. Both lights should be close to the camera so that no shadow will be cast on the inner margin of the knee joints. The photograph should not include any part of the body above the knees. The usual views for those patients able to stand are anterior and posterior, with the weight bearing on both feet. It is sometimes necessary to make lateral or medial views of foot deformities, but when in doubt the first two mentioned will serve well. If the patient with club feet is a small child or infant and bearing of the weight is out of the question, anterior and posterior views may be made while the patient is seated on the lap of an assistant. The assistant must hold the patient's knees to prevent movement of the lower legs. Bowlegs and knock-knees are photographed from the waist down, anterior and lateral. The lights should be as high as the patient's waist and directed downward. For bowlegs

the lights should be placed about two feet to each side of the camera. For knock-knees they should be placed as near the camera as possible; the knees should not touch each other and shadows should be avoided on the medial side of the knees.

*Scoliosis.* Four full length views are usually made of the subject. These are anterior, lateral, posterior, and posterior in the forward bending position. The spinous processes are carefully marked with a soft black eyebrow crayon. Ideally, four lights should be employed on all full length views, that is, two pair, each pair placed in a vertical position. Many photographers do not have access to four lights, therefore two, plus a reflector, may be employed. One light should be placed at the left of the camera at about the level of the patient's neck, and the other at the right of the camera at knee height. A waist-high white reflector is placed on the left or high light side. This will reflect light on the shadow side of the feet and legs.

*Hyperextended knees.* Photographs of these cases are usually made in the lateral position. A portable black drape may be stretched between the legs so that one leg may be photographed at a time. This will prevent the far leg from causing a disturbance because of a difference in hyperextension in the two legs. The lights are placed hip-high, tilted down, and spread out about two feet from each side of the camera.

*Foot and wrist drop.* These deformities are difficult to demonstrate photographically. They are usually made as lateral views. The leg is allowed to dangle and the photograph is made from the knee down. The lights should be placed about mid-thigh and pointed down, at a distance of one foot from each side of the camera. For wrists the picture should include the forearm but not the elbow. The arm is held in a horizontal position by an assistant. One light is placed slightly higher than the wrist and the other slightly lower and about eighteen inches farther away than the first light. The lights should be placed one-and-one-half feet to each side of the camera.

*Bone tuberculosis.* This condition may occur at any part of the bony structure. It cannot be photographed unless there is some swelling of the bone or tissue at the affected point. Lateral lighting is employed. For example, in a case of tuberculosis of the hip joint the patient is placed lying flat on his back on the examining table. One light is placed near the patient's head and is pointed toward the feet. By moving this light toward and away from the patient and watching the shadow cast by the swelling, the proper place for this light will be found. The second light should be employed to break up dark shadows. An anterior view with normal lighting is frequently of value when much swelling is apparent. Bone tumors are photographed in exactly the same manner as tuberculosis of the bone.

*Congenital dislocated hips.* If the dislocated hip is unilateral, two posterior, full length views are photographed. One is done with the weight bearing on both feet and the other with the weight bearing on the affected leg only. The other leg is flexed in front of the patient. The posterior superior spines are marked. These poses show either the positive or negative Trendelenburg sign. If the patient has bilateral dislocated hips, four full length views are made. These are posterior with the weight bearing on both feet, posterior with the weight bearing on each leg separately with the other leg flexed in front of the patient, and a lateral view to show the amount of lordosis present. The lights are employed in the same manner as when scoliosis views are made.

*Chest deformities.* Photographs of deep chest depressions are frequently difficult subjects. Lateral lighting is carefully employed in order to keep the shadows in the depression from becoming too dark. At times one light plus a reflectre will produce excellent results. Each case of this kind requires a number of experiments to obtain the best results.

*Torticollis.* Two views are always made, anterior and posterior, including the head, neck and upper trunk. A third view is often used to show the tight sternocleidomastoid cord. The lights are placed one foot to each side of the camera and on a level with the patient's face. Lateral lighting is employed to show the tight cord.

*Surgical subjects.* In the case of harelip, four views are made, anterior with the head level, anterior with the head tilted back to show the contour of the nostrils, and left and right laterals with the head level. Only the head is included in the photograph. The lights are placed one foot to each side of the camera and level with the top of the patient's head. One view is made of a cleft palate. This may be done with the Burton camera or with the aid of a head mirror (3). No variation in lighting is possible as the area to be illuminated is small.

*Hemangioma.* This variety of tumor may appear on any part of the body or extremities. Two views are made, anterior and lateral. The anterior view is made with a modified lateral lighting; the lateral view is lighted normally. Close-up views should be made with only enough of the surrounding area to serve as a landmark so that the part of the body involved may be identified.

*Burns, new and old.* New burns are photographed to show the total burned area. The lighting should vary to suit the area that has been burned. Old burns usually show keloids. A modified lateral light brings out the raised keloid very well. Grafts over burned areas may be accentuated or subdued by modified lateral light or flat light.

*Meningocele and spina bifida.* These conditions are photographically similar to hemangioma and are posed and lighted in the same manner, with the exception of spina bifida occulta. This type of tumor has a hairy mane near the base of the spine. A lateral light emphasizes this mane.

*Branchial clefts and cysts.* One view is made with lateral lighting. A horsehair is sometimes inserted in the external opening of the cleft. However, this is not necessary for the purpose of showing the location of the cleft as proper lighting will produce this effect.

*Ear deformities.* Ears are photographed in the anterior, lateral and posterior positions. Normal lighting should be employed. The lights should be kept close to the camera for the posterior view so that heavy shadows will not fall in the space between the ears and the head.

*Tumors in general.* Lateral light is nearly always employed on tumors. Usually a lateral and an anterior or posterior view are made, depending upon the position of the tumor. The lateral view is made with normal light.

*Nose.* Photographs showing the contour of the nose are made in the anterior and lateral positions. Lateral light is used for the anterior view if it is desired to show any lateral curvature of the nose. Normal light is employed for the lateral view.

No medical subjects have been recorded in this paper. They are varied and are lighted and posed in a manner similar to the orthopedic and surgical conditions discussed here. A warning should be given with regard to the use of panchromatic emul-

sions to photograph skin rashes. Panchromatic emulsions in general have a tendency to overcorrect pale red and pink. More successful photographs may be made on a color-blind or orthochromatic emulsion.

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## "THE CONFERENCES ON PHOTOGRAPHY AT THE CONSERVATORY OF ARTS AND TRADES IN PARIS"

*The American Annual of Photography and Photographic Times Almanac for 1893*

The following excerpts from the above-named article contain an early reference to the application of photography to medicine and biology. Unfortunately, the word Microphotography used in the second paragraph is incorrect. This should have been Photomicrophotography.

"On January 24, 1891 another application, very different but also very useful, Medical Photography, was treated by Mr. A. Londe, chief of the photographic department of the Hospital of La Salpetriere, to whose ingenuity and science are due most of the preparations for the study of nervous diseases and, in certain cases, the good effects of the treatment employed to cure or alleviate them. After the physiologic researches explained by Mr. Demeny, the public was acquainted with the great services rendered by photography to pathology and the art of curing.

"Microphotography was the subject of the conference of March 6th. Mr. L. Duchesne, member of the French Society, gave a review of the powerful and delicate apparatus necessary to obtain the marvelous images which divulge to us the structure, so unexpected, of the microscopic organism, and the processes as varied as ingenious that the microphotographer had to discover to solve the difficult problems of an art which requires all the resources of optics. The lecturer demonstrated by a great number of examples how useful it was to cultivate that branch of photography for the progress of the natural and medical sciences."

## NEW RAPID X-RAY FILM DEVELOPER

A new, more rapid x-ray film developer, the result of years of investigation in the Kodak Research Laboratories, is announced from Rochester by the Eastman Kodak Company.

A new product, Kodalk X-ray Developer Powders, makes possible a marked reduction in development time with normal exposure, or a normal development time with exposure reduced approximately 25 per cent. Thus, it can be used either as a time-saver or for prolonging the useful life of expensive x-ray tubes.

Kodalk X-ray Developer solution is prepared by dissolving the ready-mixed powders in water according to simple directions supplied with each package. If the user desires to save time in developing, at 65 degrees F. he reduces the optimum development time of 5 minutes to 3½ minutes. An ordinary 6-minute developing interval is reduced to 4½ minutes.

The action of the Kodalk X-ray Developer is stable and uniform. The solution has exceptionally long life and brilliant radiographs of desired density are obtained by following a simple, standardized routine.

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## THE PRESIDENT'S ADDRESS*

It is a matter of pride that our Association has been able to weather the past six discouraging years and is now holding its Seventh Convention with a goodly number of its charter members still enrolled.

Our JOURNAL, which has completed its fifth volume, stands as a monument to the willingness of our members to share their, to a large extent, self-taught craftsmanship with their less experienced colleagues.

In these volumes may be found much interesting and instructive material which has never been published elsewhere. The remaining subject matter could only be made available by diligent search in many periodicals and textbooks. Here they are conveniently presented and carefully indexed.

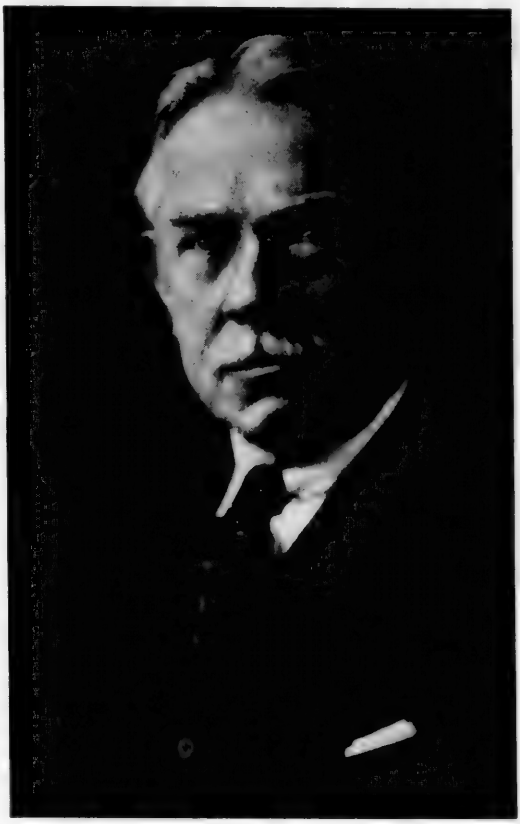
This has been a great service, not only to the photographer who serves the scientist but to the teacher and investigator for whom he works. It has also greatly aided those scientists who either must or prefer to make their own photographs. As far as we know there is no other association of biological photographers, and we use the word biological in its broad, inclusive sense.

At our first meeting in New Haven in 1931 we adopted the slogan "For the Further Study of Photography in Relation to the Biological Sciences and to Improve Its Technic." No better proof is needed that we have lived up to this motto than is afforded by the pictures in this Salon, which are far in advance of our previous efforts. These prints excel in composition, lighting and superior processing and are enhanced by careful and tasteful mounting. The light-colored mounts have justified their selection.

It is not surprising to find that color is more in evidence than ever.

* Delivered at the 1937 Convention of the Biological Photographic Association.

While the principles of color photography are far from new, it is only lately that the practical stage has been reached. We now have materials that enable the careful worker to produce photographs in color that are useful as records and satisfactory as copy for the photoengraver. Particularly in motion pictures the advance has been most satisfactory as



MR. LOUIS SCHMIDT, PRESIDENT OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

well as startling. The full descriptions of the technic and materials used are lacking on some of the prints in this Exhibition. This should be corrected next year because our public is as much interested in methods as in results.

By means of articles published, by addresses before interested groups, by the exhibitions of our Salons, and by criticisms of shortcomings in

scientific photography and pointing out ways of improvement, we hope we have contributed to the betterment that is now evident. With the improvement in our work and a growing realization of its importance, we may look forward to a greater appreciation of our efforts from those we serve. Some of us are now granted a credit line on the pages that carry our prints. Perhaps many others could get this credit upon request. Our members are again urged to impress upon their authors the importance of a full description of the photographic technic being incorporated in the description of plates, so that if anyone wishes to repeat an experiment the photographic method may also be repeated.

We have enjoyed a steady growth; our conventions have improved in enthusiasm and in attendance; we have been instrumental in placing some of our members in better positions and have helped others to find suitable craftsmen for their laboratories.

Experience in this and other photographic groups has convinced us that it is difficult to induce photographers to join craft associations. Too many still harbor the outmoded and unscientific attitude that they must guard their trade secrets. This in addition to the hard financial years, the reduced salaries and the layoffs has prevented a more rapid growth.

It is desirable that our Salons be exhibited in connection with local chapters or, where these do not exist, by a member or a group who could combine with them some of their own prints. If this were done at the time and place of a local medical or other scientific meeting, much good would accrue to the Association and prestige to the sponsors. The Association will bear all or a part of the expense if desired.

To serve those isolated members who are unable to attend conventions we have provided loan albums, one showing the methods developed at the Rockefeller Institute for Medical Research in New York, and one on photography of botanical subjects from their laboratory in Princeton, N. J. Others are in preparation. We like to have the borrower pay the transportation one way. Due to customs complications we cannot send these albums outside the United States. We are glad to advise institutions as to eligible candidates for employment in our field. We give disinterested advice for the selection of equipment to meet budgets of any amount. We want all members to freely apply to us for help in solving difficult technical problems, which will receive prompt attention. These services are rendered gratis through our Secretary.

In conclusion we want you to feel that this is your Association, that we want your help, that papers from you are wanted by our Editor and that discussions of elementary subjects are as important as highly technical procedures. We like to hear from you about your everyday experiences and that of your colleagues.

LOUIS SCHMIDT, *President*,
Illustration Division,
The Rockefeller Institute for Medical Research,
New York City.

# Association News

Extensive preparations are being made for the 1938 convention of the Association which will be held in Philadelphia, Pa., next September. A new, energetic chapter has been organized under the chairmanship of Dr. Melvin A. Dillman of the Jefferson Hospital. The first meeting, at which time organization took place, was held on December 9, 1937. Since then meetings have been held every second Thursday evening of the month at the Photographic Laboratories, Temple University School of Medicine, through the courtesy of Mr. W. J. Taylor. The members of the chapter are chiefly representatives of the various hospitals and colleges of Philadelphia.

Arrangements have been made to hold a series of lectures to be given not only by members but also by authorities on special phases of photography. The January meeting was devoted to color photography. At the February meeting the subject of photomicrography with simple apparatus was discussed by Dr. Frank Konzelmann of the Temple University School of Medicine.

The members of the Philadelphia Chapter are devoting a great deal of thought and time to the program in anticipation of the September annual meeting. Since Philadelphia is one of the important centers of medical research, an instructive meeting should take place.

* * *

Mr. Leo C. Massopust recently has published another of his interesting papers discussing various phases of infra-red photography in *The Transmission of an Invisible Radiation Through Various Chemical Solutions as Recorded by the Infra-Red Plate*, Radiology, **29**: 551–555, November, 1937.

* * *

Mr. Carl Dame Clarke, Editor of the JOURNAL, was recently elected Managing Editor of the *Bulletin of the School of Medicine of the University of Maryland*. This publication is a medical journal having a large circulation among physicians and surgeons throughout the world. The *Bulletin* is larger in size than the *Journal of the Biological Photographic Association* and is published five times a year. It is devoted mainly to articles concerning research problems, recent advances in medicine and the general treatment of diseases.

Mr. Clarke has also recently completed a book on the technic of molding and casting in relation to the biological sciences. This book is now in the process of publication by John D. Lucas & Co., 1101 East Fayette Street, Baltimore, Maryland and should be off the press in about two months.

* * *

One of our members, Dr. H. M. Dekking, Director of the Eye Clinic at Nijmegen, Holland, has brought out the first portfolio of his *Atlas of Diseases of the Eye*. Mar-

tinus Nijhoff, publisher, The Hague, has issued a leaflet regarding the Atlas, which contains an excellent color reproduction of one of the plates and the following statement:

> "This publication will consist of a total of 50 colour-photographs (magnification 3x) taken from nature, pertaining to diseases of the anterior segment of the eye. The first of the 5 portfolios is now available. The remaining 4 will appear at intervals of two months, thus completing the publication in one year. Additional portfolios may be issued later on. As this edition is intended for educational purposes, every portfolio contains both unusual cases and the more current diseases, which in some cases cannot be easily demonstrated to the student. To allow an easy episcopic projection, the prints have been reproduced on loose leaves. A short description in English, French and German of each case has been printed on a separate sheet. As great care has been taken with regard to both photography and reproduction in order to produce the very best achievement one can obtain with modern methods and materials, this publication is undoubtedly unequalled as regards the naturalness, clearness and realistic qualities of the prints."

* * *

The 1937 Salon has the wanderlust and it certainly is being satisfied. It has been exhibited in Rochester, N. Y., Pittsburgh, Pa., Albany, N. Y., New York City, Denver, Colo., Columbia, S. C. and Syracuse, N. Y., and will shortly be sent to Fulton, Mo.

This splendid exhibit of the work of members of the Association is being well received wherever it is being shown. Requests for the Salon may be made to Mr. Louis Schmidt, President of the Association.

* * *

Miss Muriel Smith is now at the Columbia County Sanatorium, Philmont, N. Y., where she has taken over the laboratory work in connection with case studies of tuberculosis. She expects to record her laboratory results by means of color film. Miss Smith was formerly at the Albany Medical College and showed our 1937 Salon there just before leaving. Many of us remember meeting her with pleasure at the Rochester Convention.

* * *

All attendance records were broken at the December meeting of the Pittsburgh Chapter when the program included 16 mm. motion pictures in Kodachrome of Jamaica, which were made by Mr. A. Avinoff, Director of the Carnegie Museum of Natural History; the Kodachrome film of *Capillary Circulation in the Mesentery of of the Rabbit*, made at the University of Rochester School of Medicine with the cooperation of the Eastman Kodak Company; and a talk on the *Technic of Photographic Negatives* by Mr. E. Byrsdorfer of the Eastman Kodak Company. In addition to the regular attendance about 45 physicians accepted invitations to view this especially appropriate program.

Another large group of members and guests attended the January meeting, when the Chapter was invited to the Laboratory of the Western Pennsylvania Hospital by

Dr. Ralph Mellon and the research staff. An interesting exhibit of the various setups for routine and research photography was on view. The program included Dr. Lawrence E. Shinn's lapse-time motion picture studies of the growth and dissociation of bacteriological colonies, a scenic film in color by Dr. Mellon, and an excellent Kodachrome film of natural history subjects which featured the raid of an ant tribe for slaves, made by John T. Brown, Jr. of Pittsburgh. Another film was contributed by the Harrison Optical Engineering Company of Hollywood. This demonstrated color motion pictures made with the use of the Harrison meter, which analyzes light in terms of its color content and indicates the proper filter to be used to keep the color value constant.

* * *

All of our members who are interested in the photography of natural history subjects, particularly in entomology, should read the article by Professor Paul Knight, *Photographing the Periodical Cicada*, Leica Photography, June, 1937.

* * *

The Elizabeth Steel Magee Hospital of Pittsburgh is developing its photographic studies for research and routine work. A generous gift from a Pittsburgh engineer has made possible the construction of new quarters which will be completely equipped for still and motion picture work, photomicrography, all types of copying and the making of lantern slides. This will greatly facilitate the photographic work of the hospital.

* * *

Dr. Milton Cohen, one of our members, has produced a 2,400 ft., 16 mm. Kodachrome motion picture film, *Complete Operative and Prosthetic Technic for Porcelain Jacket Crown Restorations*, which was chosen among the Movie Makers' Ten Best. The Ten Best are chosen annually by the editorial staff of Movie Makers Magazine out of many entries from countries all over the world. The winners, for instance, were from the United States, England, France, Japan and Mexico.

The article in Movie Makers for December, 1937, included the following comments on Dr. Cohen's film:

> "It is probably safe to say that nowhere in the world has been made a dental picture more perfect in detail than *Complete Operative and Prosthetic Technic for Porcelain Jacket Crown Restorations*. Dr. Milton Cohen has portrayed this highly intricate and skilled dental project in superb Kodachrome closeups. Not only do the ultra close shots of the work in the oral cavity achieve great fidelity as to color, but also the many operations in the dental laboratory are filmed with equal expertness. Certain steps in the procedure are portrayed by the use of heroic sized models, and these scenes were smoothly integrated with the scenes taken in the mouth of the living model. Although treating of a subject necessarily highly technical in nature, the titles were so well written that they made the film clear to a layman. The picture is distinguished by even exposure, sharp focus, good lighting and excellent camera angles. It is interesting to note that Dr. Cohen not only made the picture but also did all the work shown in it."

We learn that Mr. Ralph P. Creer, principal photographer of the Veterans Administration Facility, Hines, Ill., spoke to the staff at the Ravenswood Hospital, Ravenswood, Illinois, on January 25. The subject was *Recent Advances in Clinical Photography*. The lecture was illustrated with black-and-white and Kodachrome slides followed by 16 mm. motion pictures in Kodachrome. The same lecture also was presented before the staff of the Hines Hospital on January 27.

Mr. Creer will present a paper on *The Relation of Photography to Medicine* before the General Scientific Section of the American Medical Association at the meeting in June.

* * *

Mr. Jean Kieffer of the Norwich State Sanatorium, Norwich, Conn., presented a paper on the laminograph, an apparatus for "radiographic body sectioning," at the Fifth International Congress of Radiology in Chicago, last September.

* * *

The General Education Board has granted $135,000 to the Committee on Motion Pictures in Education of the American Council of Education for three years' support. The work of the Committee concerns a review and appraisal of educational films, the study of the technic related to films in educational programs, and the consideration of the distribution problems of medical films.

* * *

The 1937 Salon of Photography was exhibited at the University of Colorado School of Medicine, Denver, Colo., under the supervision of Mr. Glenn Mills. The exhibition was held for a period of two weeks during the school's midwinter clinic. A large number visited the show and extreme interest was evidenced in many of the examples of fine photography displayed.

* * *

We welcome the following new members to the Association:

Buffalo City Hospital, 462 Grider St., Buffalo, N. Y.
Burkley, Mrs. George, 4744 Wallingford St., Pittsburgh, Pa.
Catelli, Theodore, Kingston, N. J.
Chrysostom, Sister Mary, St. Francis Hospital, Wichita, Kansas.
Feibelmann, Gertraud S., Photographisches Instuit der Eidgenossischen Hochschule, Zurich, Switzerland.
Fernandez, Richardo F., M.D., San Juan, Puerto Rico
Hampsey, J. W., M.D., 806 May Building, Pittsburgh, Pa.
Hawkinson, L. F., M.D., Brainerd Clinic, First National Bank Bldg., Brainerd, Minn.
Helmbold, Theodore R., M.D., 5215 Celia Place, Pittsburgh, Pa.
Leister, C. W., M.D., New York Zoological Park, 185th St. & Southern Blvd., Bronx, New York City.
Madden, William J., Sea View Hospital, Staten Island, N. Y.
Maurer, John, M.D., 6607 Kimbark Ave., Chicago, Illinois.

Mulert, Justus L., 84 Woodhaven Drive, Mt. Lebanon, Pittsburgh, Pa.
Niemann, K. W., M.D., 332 West Doty Street, Madison, Wisconsin.
Plante, John, Myerowitz, Inc., 732 Fifth Ave., New York City.
Robbins, Samuel A., 145 East 60th St., New York City.
Rusin, Edward, 1020 Chestnut St., Philadelphia, Pa.
Sneider, Elizabeth, Arnold Laboratory, Brown University, Providence, R. I.
Stevens, Charles A., 1761 Brooklyn Ave., Kings County Hospital, Brooklyn, N. Y.
Tuttle, Harris B., 343 State Street, Rochester, N. Y.

* * *

On one of his periodic visits to the laboratories of members, Mr. Schmidt spent several hours with Mr. Adolph Marfaing at the Institute of Ophthalmology, Columbia University, where he does outstanding photography of the eye. Mr. Schmidt was shown the special equipment required for this type of work. He found a compact, well-arranged laboratory and a model processing room. Mr. Marfaing is now preparing a paper in which he will discuss his photographic problems and the methods employed in solving them. A description of his processing room will be given and it should serve as useful information to any member who is planning one which is small though highly efficient in operation.

ARTHUR W. FUCHS.

*343 State Street*
*Rochester, N. Y.*

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The Journal of the
Biological Photographic
Association

# AN INEXPENSIVE LAPSE-TIME DEVICE FOR RECORDING THE DEVELOPMENT OF BACTERIAL COLONIES*†

LAWRANCE E. SHINN

*Pittsburgh, Pa.*

The unit to be described in this paper is designed for a particular field of study, the subject matter of which is limited in size range and requires a degree of low magnification not obtainable with the usual type of equipment employing the compound microscope. This range would be admirably covered by suitable extension tubes but unfortunately, so far as is known, the only camera which provides such refinements and the necessary internal focusing is quite expensive. Hence the equipment described in this paper represents a compromise, both economically and optically.

## GENERAL FEATURES

The entire equipment is contained in two units, one of which is an incubator for the culture, a housing for the lights and a support for the camera. The other unit contains all the controls for speed, exposure, light intensity, etc. and houses the drive motor. The only connections between the two units are two readily detachable multiple cables and a short length of flexible drive shafting (Fig. 3*a*). The drive is of the continuous type and variable from 2 to 25 frames per hour. The exposure time is similarly variable from 0 to 60 seconds independently of the speed. The intensity of illumination is controlled by rheostats. Either reflected or transmitted light or both can be used. A frame

* From The Institute of Pathology, The Western Pennsylvania Hospital.
† Received for publication March 30, 1938.

counter is built into the control unit. The total cost exclusive of the camera is estimated to be about $60.00.

## CONSTRUCTION

*Camera.* The camera employed is an old Victor model 3 with f:3.5 lens. It is modified in the following manner: Removal of the motor casing gives access to the gearing. The hand crankshaft is removed and replaced by a new one which is turned from a $\frac{1}{4}$ inch brass rod and which projects about $\frac{3}{4}$ inch beyond the case. The end of the shaft is fitted with a $\frac{1}{4}$ inch coupling (see parts list). When reassembled the camera is unchanged, except that it is now possible to make positive connection to the drive shaft.

*Incubator unit.* The general construction of this unit is shown in Figures 2 and 3. It is built of $\frac{3}{4}$ inch pine and lined with wall board. The dimensions will vary with individual needs, but it has been found that a unit 12″ x 12″ x 12″ is satisfactory. The top of the incubator serves to support the camera which is alined by two sections of 2″ x 4″ pine (Figs. 2 and 3). A screw through the rear section engages the tripod socket of the camera, while another bearing against the case holds it firmly to the side strip. A hole through the top of the incubator accommodates the lens.

Immediately under the camera lens and fastened by a clip to the top of the cabinet is a 3.5 × double hand lens of the engraver's glass type. This serves to provide the requisite magnification and will be further discussed under the heading of "Operation."

The petri dish containing the developing culture is supported in a direct line below the lens by means of a platform which is attached to the back of the incubator by one-half of an old, discarded mechanical stage. This serves to give a vertical motion through several centimeters for focusing. The shaft of the pinion is extended by a brass rod to the side of the incubator and terminates on the outside in a bakelite knob so that focusing can be accomplished without opening the door. The platform can be fastened at either end of the rack, thus allowing two ranges of motion.

Illumination is provided by two Spencer 10-watt substage microscope lamps or similar lights. One is fastened to the floor, the other by a hinge to the roof so that the angle may be varied. A mirror serves to direct the first light up through the object to be photographed. Ground glass diffusers for the transmitted light are put in as required.

The thermostat is homemade and of the bimetallic strip type with silver contacts. It operates on 6 volts AC (Fig. 1). To prevent chatter of the heater relay a thermostatic relay of the time-delay type is used (Figs. 1 and 2). This is made by winding a narrow bimetallic strip (which has been insulated with tape) with fine resistance wire. It is adjusted to give about a 30 second lag.

*Control Unit.* This part has a triple purpose. First, it provides an easily variable mechanical drive which is suitably reduced in speed and is transmitted by a flexible shaft to the camera. Second, it provides a means of turning on and off the lights at the correct shutter phase and an easily variable control over the length of the exposure up to the limit set by the speed of the camera. Third, it houses the relays necessary to control the 110 volt circuits and the transformer which provides the 6 volts used on all control switches to prevent contact failure (Fig. 1). This entire unit is housed in a 7″ x 10″ x 18″ cabinet, and all controls are brought out on a radio panel. The internal construction can be followed in Figures 2 and 3.

The drive motor is a Senco Vari-Speed with a final shaft speed of 0 to 10 r.p.m. This type of motor has a built-in disc drive, the control shaft of which is brought through the panel (left-hand dial). In order to further reduce the speed to the value required without building up complicated and expensive gear trains, a series of three units known as planetary speed reducers and sold as standard radio parts has been installed. These are very compact and inexpensive and couple in a straight line, each unit providing a reduction of 5.5 times. Thus the final speed obtained can be varied from 0 to 0.06 r.p.m. by changing the motor dial. Since the camera used takes 7 frames per revolution, this means a range of 0 to 25 frames per hour. The range could be varied, of course, by using either two or four reducers. For photographing bacterial colonies 2 to 20 frames per hour is ample. It was found necessary to reverse the direction of shaft rotation by one stage of 1:1 gearing at the end. The line of reducers requires only a single bushing for support and they are kept from turning as a whole by keeper rods through the mounting holes (Fig. 3). Any tendency to slip is taken care of by removing the grease packing in the units and reassembling them with a few drops of light oil.

The master timing for exposures is taken directly from the camera shaft by a 7 point cam which operates a small spring SPDT switch

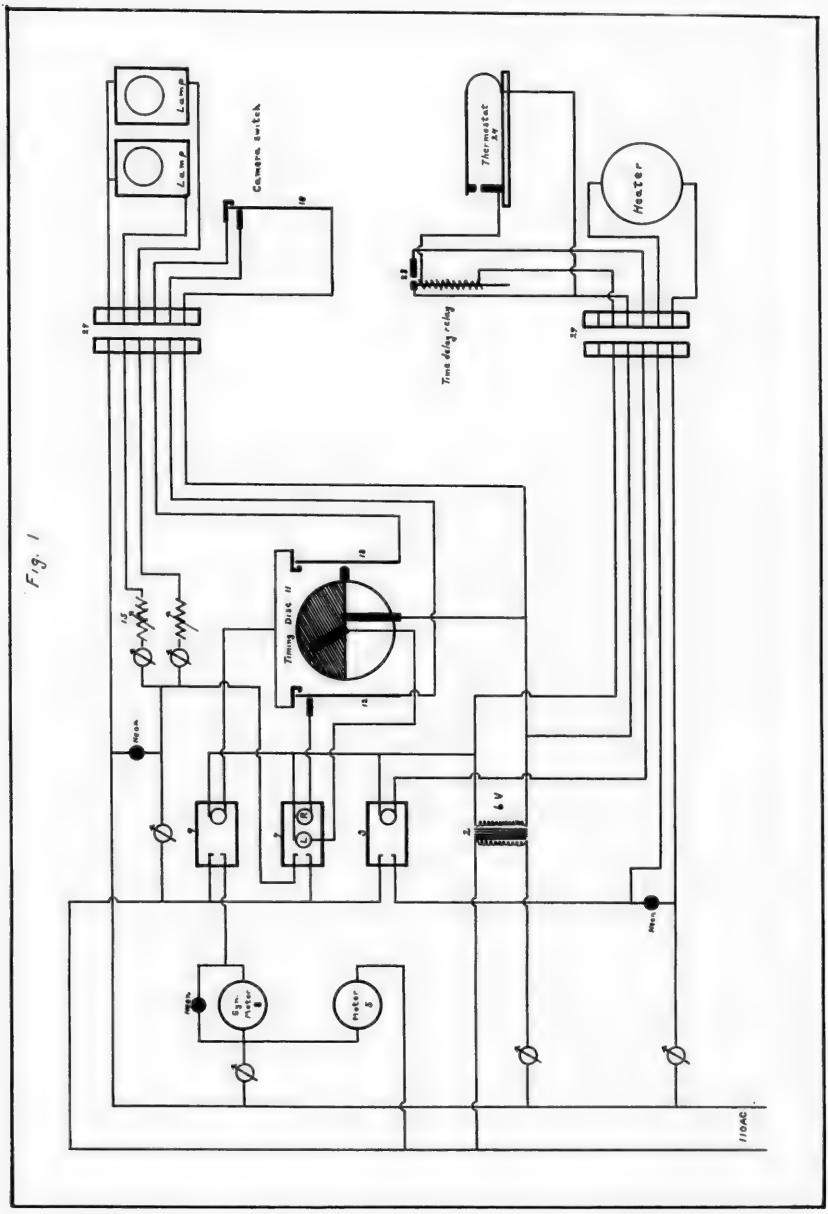
Lamp
Lamp
Camera switch
Thermostat
Heater
Time delay relay
Timing Disc II
6 V
Meter 4
Meter 5
110AC

Fig. 1

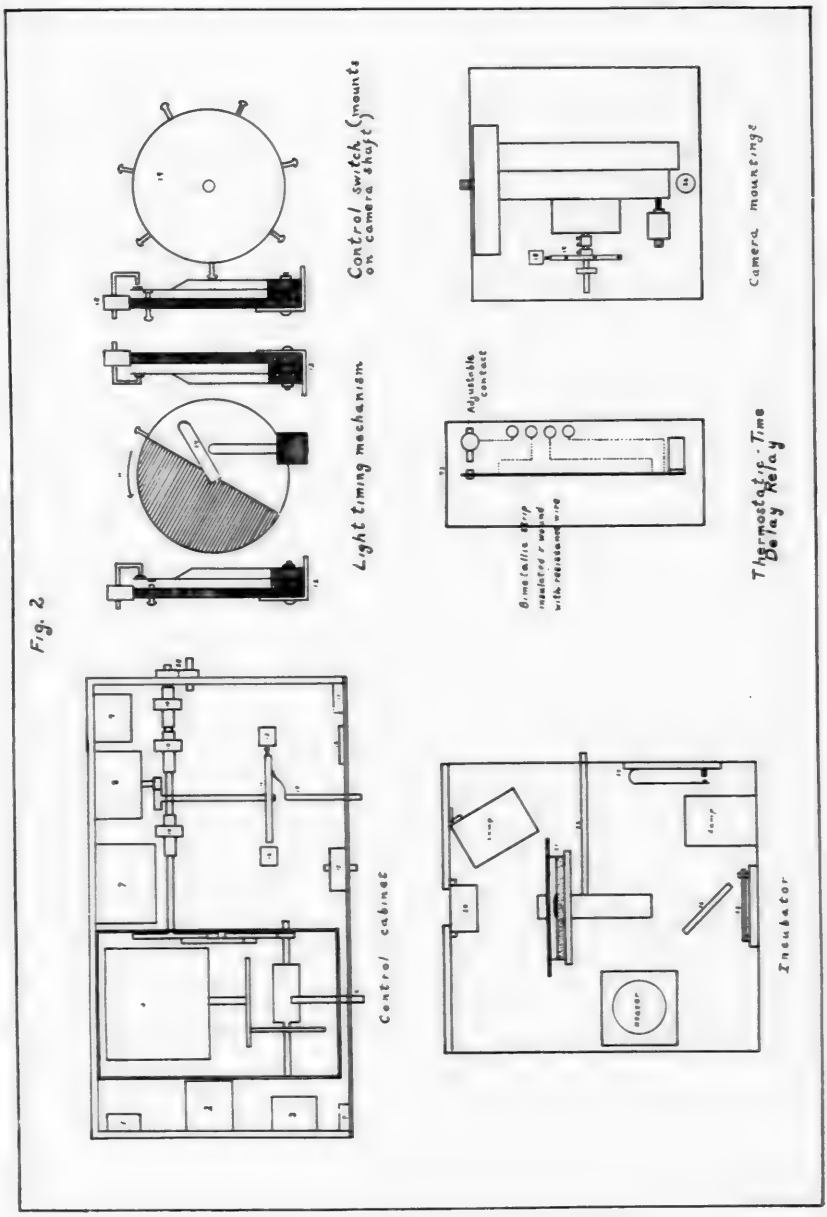
Control switch (mounts on camera shaft)
Camera mounting
Light timing mechanism
Thermostatic Time Delay Relay
Control cabinet
Incubator

Fig. 2

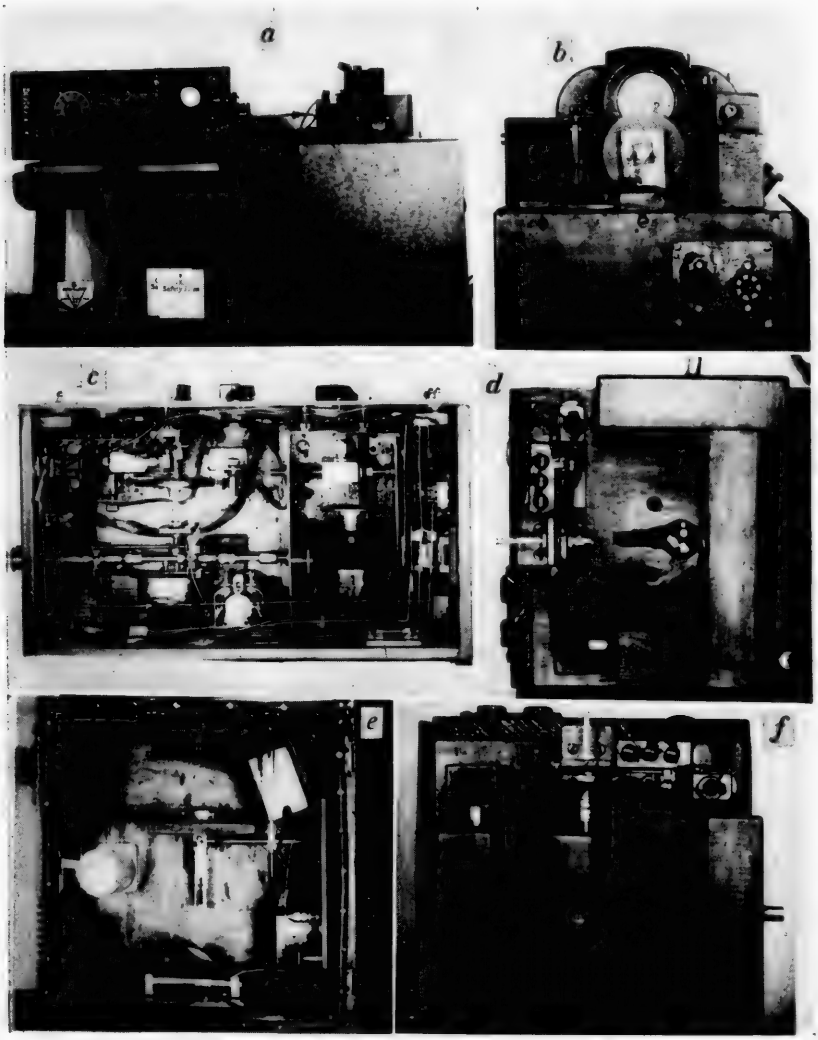


FIG. 3

*a*. The complete unit in operation
*b*. A side view of the camera mounting to show master cam and switch
*c*. Interior of control unit
*d*. Top view of camera mounting (camera removed)
*e*. Interior of incubator (compare Fig. 2)
*f*. As (*d*) camera in position

mounted on the incubator (Figs. 2 and 3). The cam is so set with reference to the shaft that the switch is depressed just as the shutter completely opens. By reference to Figure 1 it will be seen that this closes the circuit to the relay controlling the synchronous motor. This motor through a 1:2 gear reduction rotates a 3 inch masonite disc just back of the panel. This disc is faced with thin brass, one-half of which is insulated with shellacked paper. Two contacts bear on the face. One of these is fixed and the other can be rotated through 180° by varying the setting of the right-hand dial. Two spring switches are operated by a single cam on the periphery (Fig. 2). These are connected to the two poles of the master switch at the camera. The disc will rotate until the cam breaks the circuit which is operative at the time (one-half revolution) and then stops. As the camera shaft continues to turn, the opposite pole of the master switch will be closed when the shutter has closed. Since this pole is connected to the other switch at the exposure disc, the synchronous motor will again be activated and turn through the other one-half revolution. During the first half both contacts will rest for a portion of the time on the brass. The point at which this occurs is controlled by the angular setting of the movable contact. At this point the latch relay controlling the light is closed. It will be noted that, as the disc completes this half of its cycle, its cam closes the rear contact of the left-hand switch (Fig. 2). This unlatches the relay and turns off the lights. At this point the fixed contact has passed slightly on to the insulated phase so that there is no relatching. Thus the disc permits variable exposure through one-half of its cycle (shutter open) and no exposure during the second or resetting half (shutter closed). The frame counter which is mounted on the panel is connected to the end of the exposure disc shaft by a length of spring from a discarded cable release.

## OPERATION

The glass petri dish containing the colony to be photographed is placed on the stage. The plate cover is replaced by a piece of clear glass. The drive shaft is now uncoupled from the camera and slipped out, and the camera is released from its mountings and removed. This gives a view of the subject through the hand lens. One is now able to focus on the colony by employing the device which the author described (J. Biol. Photo. Assn., Vol. 6, p. 33, 1937) in connection with the employ-

ment of the hand lens as an adjunct to the 35 mm. miniature camera in colony studies. In the case of very large colonies one-half of the hand lens can be removed and the platform set at the bottom of the rack instead of at the top. With the focusing device described one is assured that the object will be in focus when the camera lens is set at infinity.

The camera is now replaced in its mount and the drive shaft connected with care that the cam shall be in proper relation to shutter phase. This is best done by referring to marks on the hub of the cam disc and on the camera shaft. The speed, light intensity and exposure time are set on the dials as desired, the motor switch is closed and the machine requires no further attention.

The colony can be observed at any time during exposure (or the lights can be turned on by the shunt switch when desired) through an opening in the top of the incubator which is covered when not in use. The slanting tube seen in front of the camera in Figure 3 is included for this purpose. Periodic readings of the frame counter will give a check on the functioning of the mechanism and an accurate measure of the amount of film used for any subject. If notes are kept it is possible to calculate later the exact time between any two points on the film. The accuracy of the timing is very satisfactory. At an average speed of 10 frames per hour no drift greater than 1 per cent has been noted in five days.

There will be no difficulty with fogging of the cover glass if the temperature remains fairly constant. At infrequent intervals it may be necessary to clean the silver points on the spring switches with fine sandpaper. Some slight difficulty was experienced with the brass disc and it is probable that thin foil silver would serve better. Both black and white and Kodachrome Type A give good results, and the expensive high speed films are of no advantage since there is ample time for exposure. As a rule, the lens of the camera is stopped down to f:11 or f:16 and exposure times of 15 to 35 seconds employed.

These studies have given excellent results with widely varying subjects. The primary purpose was to record colonial variations such as the transformation of mucoid strains to smooth strains by wedge formation at the margin or, similarly, the transformation of smooth to rough. This material photographs well. An interesting record was obtained on an actinomycete which forms aerial conidia at periodic intervals with a resulting pattern of concentric rings. Excellent results on the mode of forming convolutions in such species as M. tuberculosis have been

recorded. The growth and conidia formation of molds such as A. niger give beautiful pictures in color, as do the intense pigment formers such as S. marcescens. At present the author is greatly interested in studying the colonial migrations of B. alvei, a strain in which the entire colonies move about over the surface of the medium. The primary value of the equipment will undoubtedly lie, however, in the field of variation or dissociation.

## PARTS

Exclusive of the camera, the parts of this device have not cost in excess of $60.00. This is because many standard radio parts have been adapted instead of using specially made units. For the readers' convenience a list is appended. Source and catalogue numbers are given in order to avoid lengthy descriptions. The synchronous motor may be salvaged from an old clock. By employing many of the small parts listed, such as couplings and bearings, the shop work is cut to a minimum and construction becomes assembly.

STANDARD RADIO PARTS[1]

| | | |
|---|---|---|
| 1 hard rubber panel | 7 x 18 x $\frac{3}{16}$ | #1902 |
| 6 toggle switches | 3 amp. SPST | #3656 |
| 6 on, off plates | | #1018-E |
| 3 neon lamps | $\frac{1}{4}$ watt | 1537-A |
| 2 brass dial plates | 3 in. | #3160-A |
| 2 brass dial plates | $1\frac{7}{8}$ in. | #3174-A |
| 2 knobs | $2\frac{1}{4}$ in. | #3183 |
| 2 knobs | $1\frac{1}{4}$ in. | #3182 |
| 4 plugs | male, 6 prong | #3758 |
| 4 panel sockets | 6 contact | #6511-A |
| 4 ft. dynamic speaker cable | 6 lead | #4149-B |
| 2 fuse mounts | | #3841 |
| 2 fuses | 3 amp., 5 amp. | #2451 |
| 3 sockets, panel mounting for neon lamps | | |
| 2 ft. bronze dial belting | $\frac{3}{16}$ x .005 | #1015-F |
| 3 planetary reducers | | #1099-E |
| 3 panel bearing assemblies | | #1066-E |
| 3 panel bearings | | #1067-E |
| 6 couplings | $\frac{1}{4}$ x $\frac{1}{4}$ | #3539-A |
| 1 transformer | | 3429-A |
| 2 rheostats | 25-watt, 1000 ohm | #2918-G |
| 1 flexible coupling | | #3559-B |
| 6 binding posts | | #1019 |

[1] Cameradio Co., Pittsburgh, Pa. (1937 catalogue).

### Motor[2]

| | | |
|---|---|---|
| 1 Senco Vari-Speed with 0–10 reduction | | |

### Relays[3]

| | | |
|---|---|---|
| 2 relays | 6 volt AC | #ABTX1 |
| 1 relay | 6 volt AC | #ABUY5N with auxiliary contacts |

### Miscellaneous[4]

| | |
|---|---|
| 1 counter | #5-100 |
| 1 hand lens | #12-060 |

### Key to Drawings

| | | | |
|---|---|---|---|
| 1 | input | 15 | rheostats |
| 2 | transformer | 16 | counter |
| 3 | heater relay | 17 | switch (light shunt) |
| 4 | switch bank | 18 | master timing switch |
| 5 | drive motor | 19 | master timing cam |
| 6 | speed control | 20 | hand lens |
| 7 | light relay | 21 | culture |
| 8 | synchronous motor | 22 | focusing control |
| 9 | synchronous motor relay | 23 | time-delay relay |
| 10 | speed reducers | 24 | thermostat |
| 11 | exposure disc | 25 | mirror |
| 12 | spring switch | 26 | viewing aperature |
| 13 | spring switch | 27 | connecting cables |
| 14 | exposure control | 28 | reversal gears |

The author has since located (Allied Radio Co., Chicago) small 1/6 gear reduction units which are compact, inexpensive and require no additional construction for installation. These appear to be an improvement over the planetary units for reduction of shaft speed.

[2] Sundt Engineering Co., Chicago, Ill.
[3] Struthers Dunn Inc., Philadelphia, Pa.
[4] Fisher Scientific Co., Pittsburgh, Pa.

# AN ILLUMINATING SYSTEM FOR LARGE TRANSPARENT SECTIONS IN PHOTOMICROGRAPHY*†

JOHN V. BUTTERFIELD

*Rochester, N. Y.*

The term *Photomicrography* is generally thought of as applying to photography with a compound microscope, using objective and eyepiece combinations which give magnifications from about 25 or 50 diameters up to perhaps several thousand diameters. A great deal of work is done within this range and a considerable variety of equipment is offered the worker in this field.

Photomicrography, however, includes the photography of specimens at low magnifications, below the range obtainable with the compound microscope, and usually the fields one desires to cover are larger than the illuminating systems and optical combinations of the microscope will include.

To cover the lower ranges of magnification it is necessary to resort to a single taking lens or objective, properly designed, which is used alone in the camera. The objective lens performs in a manner just reversed from that of an ordinary view camera, that is, the objective distance is shorter than the bellows extension of the camera and gives a magnified instead of a reduced image. Special short focal length objectives are made for this type of work and are designated as *Micro-Planars*, *Micro-Tessars*, etc. The focal lengths in which they are made range from about 16 mm. to 75 mm. and these particular objectives require certain modifications of the regular microscope illuminating system. Auxiliary lenses are necessary to illuminate the fields they will cover. These auxiliary lenses or condensers are usually designed to work with the illuminating unit supplied for use with the compound microscope. As a rule, this unit is fitted with a lens system probably mounted permanently so that it helps to determine a limit to the largest field which may be covered in low power work.

The illuminating system for the microscope to be used in photography has been a subject of considerable discussion and the optics involved have become almost as well standardized as has the illumination method.

* From the Scientific Bureau of the Bausch and Lomb Optical Co.

† Read at the 1937 Convention of the Biological Photographic Association.

Owing to the small fields and short focal length lenses used, the overall distance from the illuminant to the specimen plane can be made comparatively short and the parts conveniently built on to an optical bed with the camera. However, this may not hold true when it is desired to do low power work.

One system recommended for use in low power work consists of a lens, or lenses, introduced near the illuminant to provide a beam of parallel light with a second lens placed immediately behind the mounted speci-

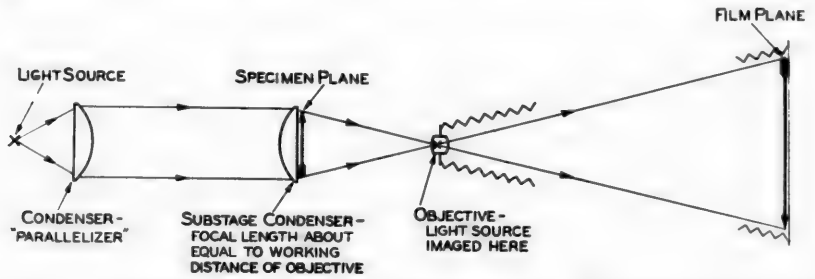
FILM PLANE
LIGHT SOURCE
SPECIMEN PLANE
CONDENSER - "PARALLELIZER"
SUBSTAGE CONDENSER - FOCAL LENGTH ABOUT EQUAL TO WORKING DISTANCE OF OBJECTIVE
OBJECTIVE - LIGHT SOURCE IMAGED HERE

FIG. 1. A system of illumination for low power work. The lamp condenser should be a corrected lens of long focal length.

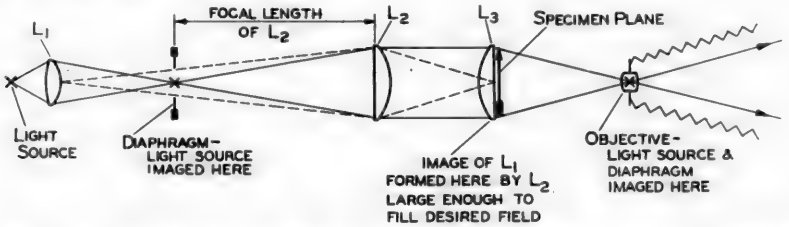
L1
FOCAL LENGTH OF L2
L2
L3
SPECIMEN PLANE
LIGHT SOURCE
DIAPHRAGM - LIGHT SOURCE IMAGED HERE
IMAGE OF L1 FORMED HERE BY L2 LARGE ENOUGH TO FILL DESIRED FIELD
OBJECTIVE - LIGHT SOURCE & DIAPHRAGM IMAGED HERE

FIG. 2. In this diagram the light source and $L_1$ represent a typical illuminating unit designed for use with a microscope, $L_2$ is a lens of 6 or 8 inches focus. $L_3$ is the substage condenser with a focal length about equal to that of the objective. This system requires a long optical bed.

men. The requirements specify that the second lens must be filled evenly with light and in turn focus the light into the objective. Such a system is illustrated in Figure 1.

Very good illumination may be obtained by introducing lenses between the regular lamp condenser and the specimen to serve the purpose of relaying an enlarged image of the lamp condenser to the specimen plane and then converging the light into the objective. This system is illustrated in Figure 2.

Either of these systems requires an appreciable amount of room be-

tween the lamp and the specimen, and if it is desired to illuminate a field much over 30 or 40 millimeters in diameter the illuminating system becomes extended and unwieldy. In addition, the lenses involved are not usually at hand and considerable time may be consumed in trying to "rig up" a system to fit the occasion.

To answer such a situation, illuminators have been made and described wherein several lamps have been arranged in a box or frame to give an even distribution of light over the surface of a plate of ground or opal glass. The specimen is then supported in front of the illuminated plate and the camera lined up perpendicular to the plane of the plate and specimen. This system is not particularly efficient since several lamps of considerable intensity are required to give the amount of light desired for focusing and convenient exposure. A great deal of light is lost and the heat from the lamps may be objectionable.

The system to be described eliminates the objections of the illuminating systems mentioned by allowing a comparatively short distance from illuminant to specimen. This permits the parts to be attached to the optical bed of the photomicrographic outfit and leaves sufficient room for long camera extensions. Also, a single light source of standard type is used and operates with greater efficiency.

The principle of this particular illuminating system is not new. It has been used in lantern slide projection, enlarging equipment and similar apparatus for many years.

In the book "Practical Photomicrography" by Bernard and Welch, the statement is made that the photography of large sections or similar transparent objects by transmitted light is, in some respects, the most difficult branch of photomicrography. This is due mainly to the illumination difficulties. These authors suggest the use of a projection-lantern condensing system. A similar suggestion is made by Hind and Randles in their "Handbook of Photomicrography." The illumination principle is illustrated in each case, but the photographer probably does not have access to a projection lantern which may be taken apart and adapted to the job.

In one particular case the author was confronted with the task of making a series of about 40 photomicrographs of sections of the human brain stem. It was necessary to cover the entire section in each case and reproduce it at about 3× magnification to fill an 8″ x 10″ plate, and to take smaller areas of certain sections and reproduce these at about

10× to fill an 8″ x 10″ plate. These sections were mounted on glass plates of lantern slide size with a somewhat smaller cover glass. An illuminated field of about $3\frac{1}{2}$ or $3\frac{3}{4}$ inches diameter was required. Such a large field was beyond the scope of a 72 mm. Micro-Tessar and its illuminating condenser, therefore this special illuminator was devised.

Figure 3 illustrates the principle of the illuminator. The light source is indicated at the extreme left and the condenser system is immediately in front of it. The condenser is made up of three elements to provide an efficient system. Shown in dashed lines is a finely ground glass plate which may be used if desired. The use of this plate destroys the actual image of the light source, diffuses the light slightly and covers a larger aperture at the objective.

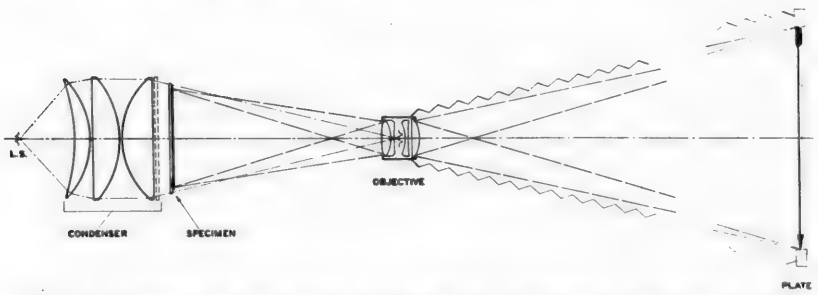


FIG. 3. Illustrating the principle of the special illuminator described in the text. By adjusting the spacing of the condenser lenses or changing the lens nearest the specimen the focal length can be altered to conform to the focal length of the objective.

The focal length of the condenser combination is chosen to give an image of the light source at a distance from the front of the condenser about equal to the working distance of the objective used.

The specimen is supported directly in front of the condenser as indicated by the arrow.

The objective should be a well corrected lens mounted with the front toward the photographic plate, that is, exactly reversed from the position in which it would be used for portrait or similar work.

The objective used in this case was a Bausch & Lomb Series II-B Tessar of $8\frac{1}{4}$ inch focal length, an f:6.3 objective stopped to about f:11.

Lines indicate the marginal rays forming the image on the photographic plate at the extreme right.

Figure 4 shows the complete illuminating unit as made up. The mechanical construction happens to be a standard unit which is designed

for use in macrophotography, with a vertical illuminating system. Standard Balopticon condenser lenses are used and a standard light source such as the 6-volt ribbon filament Mazda, the $4\frac{1}{2}$ ampere carbon arc or the one illustrated which has just recently been introduced, may be attached.

The condenser system is shown partly disassembled in Figure 5. One of the lenses has been removed. The ground glass disc is also seen at the base of the condenser support. The mounting of the lenses is quite simple and adjustment is provided in the separation of the elements so that some change in focal length may be made.

FIG. 4. Complete condenser system and support with lamp housing attached.

FIG. 5. Condenser system with ground glass and front lens removed.

FIG. 6. The specimen support with vertical and horizontal adjustments.

Figure 6 shows the details of the specimen support which was made up especially for the job. It is provided with vertical and horizontal centering adjustments. This particular support was made to accept only one size of slide; changes could be made, however, to accommodate other sizes.

Figure 7 shows the complete setup in position for use on the standard Bausch & Lomb photomicrographic outfit. The specimen support is shown in proper position for use with the $8\frac{1}{2}$ inch lens, but for the 10×

FIG. 7

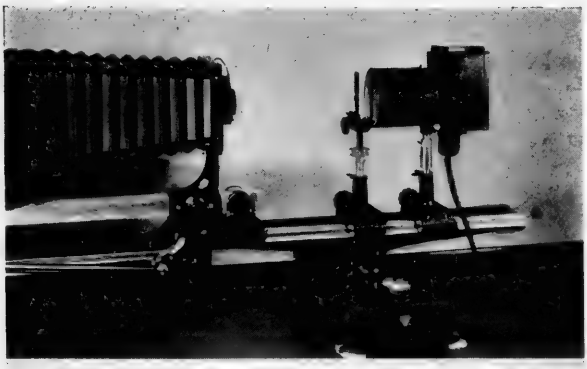

FIG. 8

FIG. 9

FIG. 7. Illuminator and specimen support attached to optical bed of the photomicrographic camera. The ribbon filament lamphousing is shown.

FIGS. 8 AND 9. Parasagittal sections through the human brain stem taken with the illuminator described. Original magnification 3.5×, reduced 3.1× in reproduction. Objective, Bausch & Lomb Series II B Tessar, $8\frac{1}{4}''$ E.F. stopped to F: 11. Source, tungsten arc. Wratten Metallographic plate.

Section in Fig. 8 stained with thionin. Negative exposed 1/25 second with B filter and developed in D-19, 8 minutes.

The section in Fig. 9 is a Weigert preparation. Negative exposed 2 seconds with H filter and developed in D-76C, 7 minutes.

exposures a 72 mm. Micro-Tessar lens was substituted in the camera and the support moved up toward the objective until the specimen came into focus. At this position the cone of light from the illuminator was sufficiently large to cover the field desired.

One of the sections photographed with this system is shown in Figure 8. This particular specimen was a parasagittal section through the brainstem. It was stained with thionin, presented little contrast and was very transparent. Satisfactory illumination was obtained, however, and sufficient contrast built up by the use of proper filter and plate development.

Figure 9 shows another of the specimens photographed. In this case the section had been treated by one of the reduced silver processes which produce very high contrasts within the specimen. The illumination was entirely adequate and produced satisfactory evenness and detail. Opposed to the treatment of the negative for Figure 8, however, the negative for Figure 9 was processed in a softer working developer.

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## DETERMINING EXPOSURE TIME OF PHOTOMICROGRAPHS WITH THE INSTOSCOPE EXPOSURE METER AND A CIRCULAR SLIDE RULE FOR CINÉPHOTOMICROGRAPHIC EXPOSURES*†

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ABSTRACT

Exposure time in photomicrography = standard exposure × the magnification factor × the filter factor × the factor for the numerical aperture of the objective, but since the standard exposure varies with the density of the object, with the types and the intensities of illumination, and with other variables, the standard exposure must be determined by trial exposures for each given case. Light intensity can be measured by photocells constructed to fit certain conditions; however, as the common photocell exposure meters can only measure very high light intensities, photomicrographic light values for the *Instoscope* have been determined

* From The Institute of Paper Chemistry.

† Received for publication March 18, 1938.

and charts have been constructed which make possible the accurate determination of standard exposure and actual exposure time for all possible conditions of illumination and magnification in photomicrography.

Because of the complex nature of cinéphotomicrographic exposure determinations, a circular slide rule has been constructed which makes it possible to determine such exposures by setting the slide rule at the given Instoscope value, turning the slide top part clockwise to the number of frames per second to be used, and then reading directly the possible opening of the shutter sector, the filter to be selected and the neutral screen to be used for proper exposures.

Every microscopist who is familiar with photomicrography knows that the exposure time for photomicrographs equals the standard exposure × the factor for magnification × the filter factor × the factor for the numerical aperture of the objective used. The unknown factor in this equation is the standard exposure.

Standard exposure varies not only with the density of the object, the source of illumination, the arrangement of the auxiliary condensers, the numerical aperture and the focusing of the substage condenser, but also with the aperture of the field diaphragm of the auxiliary condenser and the aperture diaphragm of the substage condenser. The microscopist also knows that the exposure varies directly as the square of the magnification and also as the square of the camera length.

However, even if the standard exposure time were known, the magnification factor, the filter factor and the factor for the numerical aperture of the objective used would have to be employed in calculating the exact exposure.

To overcome these difficulties some microscopists make an accurate record of each successful photomicrographic plate and, when a similar photomicrograph has to be made, merely refer to the previous record, make a test plate with exposure times varying in geometrical progression below and above the exposure used previously under similar conditions, and then determine the correct exposure from the results of the developed test plate. By this method one can, of course, make fairly good plates, but it requires extra plates and extra time.

In its final analysis the determination of the standard exposure time depends upon the intensity of the light at the eyepoint of the microscope after the illuminant, the condensers and the objective have been adjusted

to give the desired image on the ground glass. This intensity can be measured with a photocell if the construction of such a cell is made to fit certain conditions.

The intensity of the light cannot be measured at the surface of the ground glass, as all of the light emerging from the ocular must be covered by the active area of the photocell. It is necessary, therefore, to have a connective tube which fits the microscope tube at the eyepiece, with or without the ocular, and which is long enough so that all of the sensitive surface of the photocell is exposed to the light and the remainder of the instrument rests upon it (1).

By means of tests with one of the common types of photocell exposure meters the author found that the particular photocell used was not sensitive enough except to very intense light, such as would require an exposure on a W.W.M. plate 25 cm. from the eyepoint of from 0.01 to 0.10 second. Since that is a very limited range of light intensities for photomicrography, such an exposure meter would not be satisfactory.

Experiments were therefore made with the Drem Exposure Meter Instoscope (Fig. 1).[1]

The design of this exposure meter completely eliminates any anticipated exposure reading. The instantaneous reading obtained is positive and definite under any light condition. The light values as observed in the meter are expressed in a succession of letters arranged in the same manner as on an optician's test chart. This arrangement will prevent guessing at or forcing of any well-known and habitually memorized selective symbol or number, and will correct possible errors of over-reading.

In using this exposure meter it is necessary, as with the photocell, to have all of the light at the eyepoint cover the active area of the meter, and for this purpose an adapter (Fig. 2) has been designed. The adapter is placed over the microscope tube so that diaphragm 2 rests upon the tube, with or without the ocular, and the Instoscope is put in the other end of the adapter tube so that it rests upon diaphragm 1.

When using the Instoscope the eyecup is placed against the eye so that extraneous light is excluded, and the outer tube is moved in or out until the letters in the meter are sharply defined. After condensers and diaphragms have been adjusted according to the type of illumination desired and the image has been sharply focused on the ground glass at

[1] Photo Utilities, Inc., 10 West 33rd St., New York City.

its proper magnification, the camera is disconnected from the microscope, the Instoscope adapter with diaphragm 2 is placed over the microscope tube and the Instoscope with the letters in sharp focus is placed on diaphragm 1. All extraneous light is carefully excluded and the eye placed against the eyecup. Starting from the brightest letter "A" and reading down, one decides which is the dimmest or faintest letter that is readable. This should take only a few seconds. The faintest legible letter is noted and the eye immediately removed from the meter.

FIG. 1

If the last readable letter is "L", as shown in A of Figure 3, the standard exposure factor for this letter, which by experiments has been found to be 0.02 second, is taken; if the last readable letter is "V", as shown by B of Figure 3, the standard exposure factor is 0.18 second; if the last readable letter is "F", as shown by C of Figure 3, the exposure factor is 1.20 seconds. By using illuminations of different intensities test exposures on W.W.M. plates were made, the actual standard exposures at 25 cm. from the eyepoint were determined, and these exposures were plotted against the corresponding last legible letter for these exposures

as shown in Figure 4. This chart shows that the standard exposures for the light values of the different letters, when plotted on a semilogarithmic chart, are linear, and, since exposures vary as the square of the distance from the eyepoint to the ground glass, the exposure factors for the different camera lengths can be read from a curve as shown in Figure 5.

In this chart the standard Instoscope exposure values for W.W.M plates at 25 cm. from the eyepoint are listed in the margin. These exposure factors × the factor for the camera length will give the exact

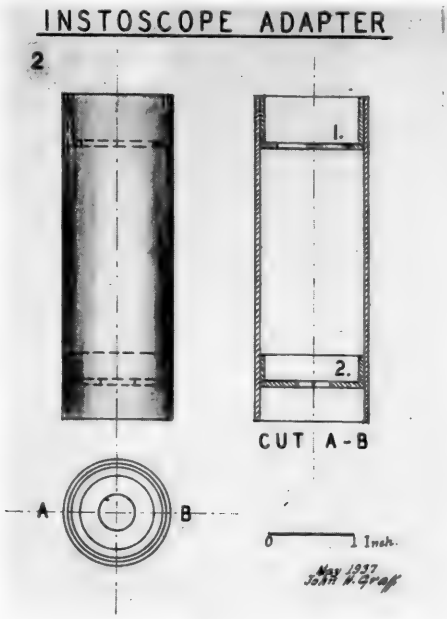
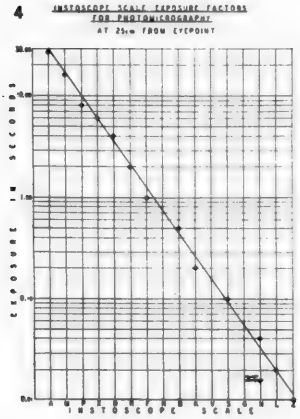


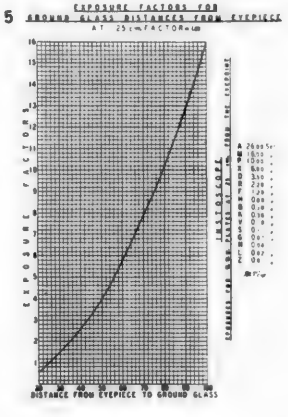

FIG. 2

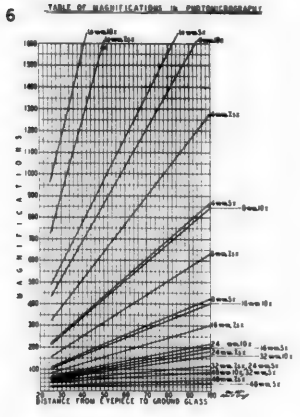
FIG. 3

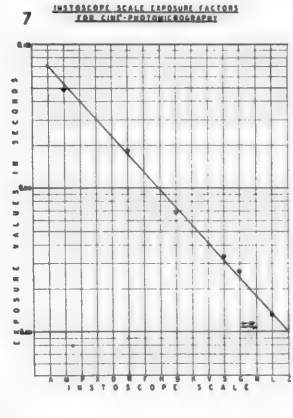
exposure time on W.W.M. plates under all possible conditions of illumination and optical combinations of the microscope. If filters must be used it is best to determine from the chart the exact exposure needed without a filter and then to multiply this by the filter factor. If sensitive materials other than W.W.M. plates are used, it is necessary to compensate for the relative speed of these emulsions after determining the standard exposure.

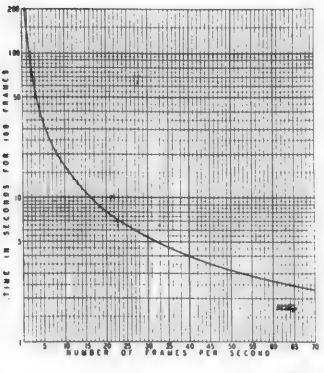
Since in some photomicrographic setups it is somewhat difficult to determine the exact projection distance from the eyepoint to the ground

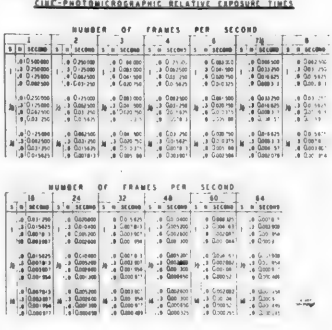

4
INSTOSCOPE SCALE EXPOSURE FACTORS
FOR PHOTOMICROGRAPHY
AT 25cm FROM EYEPOINT
EXPOSURE IN SECONDS
INSTOSCOPE SCALE


5
EXPOSURE FACTORS FOR
AROUND GLASS DISTANCES FROM EYEPIECE
AT 25cm FACTOR=1.00
EXPOSURE FACTORS
INSTOSCOPE
DISTANCE FROM EYEPIECE TO GROUND GLASS


6
TABLE OF MAGNIFICATIONS IN PHOTOMICROGRAPHY
MAGNIFICATIONS
DISTANCE FROM EYEPIECE TO GROUND GLASS


7
INSTOSCOPE SCALE EXPOSURE FACTORS
FOR CINE-PHOTOMICROGRAPHY
EXPOSURE VALUE IN SECONDS
INSTOSCOPE SCALE


8
TIME IN SECONDS FOR 100 FRAMES
NUMBER OF FRAMES PER SECOND


9
CINE-PHOTOMICROGRAPHIC RELATIVE EXPOSURE TIMES
NUMBER OF FRAMES PER SECOND

FIGS. 4–9

glass, it is better to determine the magnification used by projecting a stage micrometer scale on the ground glass, adjusting the projection distance to the magnification desired, and then reading the actual camera length from a chart similar to that shown in Figure 6. This chart has been made for some of the more common combinations of objectives and oculars.

This method of determinng the exposure time has proved very satisfactory as the operator need judge only the method of development of the negative for the contrast desired. As a result better and more uniform negatives have been obtained and considerable time and many plates have been saved.

## CINÉPHOTOMICROGRAPHIC EXPOSURES

In cinéphotomicrographic work the sum total of the light is focused on a much smaller area than in ordinary photomicrography and for this reason the exposure values for the different light intensities will be different. These light values have therefore been determined by trial exposures on Ciné-Kodak panchromatic film and the results plotted in Figure 7. Here, as in ordinary photomicrography, it is advisable to determine the exposure values without the filter.

In cinéphotomicrography the actual exposure time depends upon the number of frames per second, which again depends upon the rapidity of the movements to be recorded. As the number of frames per second with motor-driven attachment can be varied from 1 to 64, and since the only method of controlling the exposure at different light intensities is by the three different openings of the shutter sector and the four different values of the neutral screens in the connecting headpiece between the microscope and the Ciné-Kodak, the exposure time must be calculated not only for the different light intensities, but also for the number of frames per second at the different intensities of light and for the filters to be used.

### *Number of frames per second*

As a rule 160 frames or 10 seconds at normal speed is sufficient for scenes in which the character of the action is not changed, therefore experiments must first be carried out to determine the rapidity and the duration of the movements which are to be recorded. The curve in Figure 8 shows the time in seconds necessary for 160 frames with a varying number of frames per second.

*Shutter sector and neutral screens*

The shutter sector revolves once for each frame exposed, but as the opening of the sector at 1, $\frac{1}{2}$ and $\frac{1}{4}$ is only $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ effective for each revolution, it is seen that for one frame a second the actual exposure time at 1, $\frac{1}{2}$ and $\frac{1}{4}$ is 0.500, 0.250 or 0.125 second, and that at 64 frames a second the actual exposure time at 1, $\frac{1}{2}$ and $\frac{1}{4}$ is 0.00782, 0.00391 or 0.00196 second.

The neutral screens in the revolving disc are marked 0.0, 0.3, 0.6 and 0.9, which means that while the screen marked 0.0 does not reduce the intensity of the illumination, 0.3 reduces the intensity to $\frac{1}{2}$ and 0.6 and 0.9 reduce the intensity to $\frac{1}{4}$ and $\frac{1}{8}$ respectively. Therefore, if at one frame a second the shutter sector were set at 1 and gave 0.500 second actual exposure time, and the screen were set at 0.9, the effect would be equal to 0.0625 second actual exposure time; if at 64 frames a second the shutter were set at $\frac{1}{4}$ and the screen at 0.9, the exposure would be equal to 0.000244 second. These relative exposure times are shown in Figure 9.

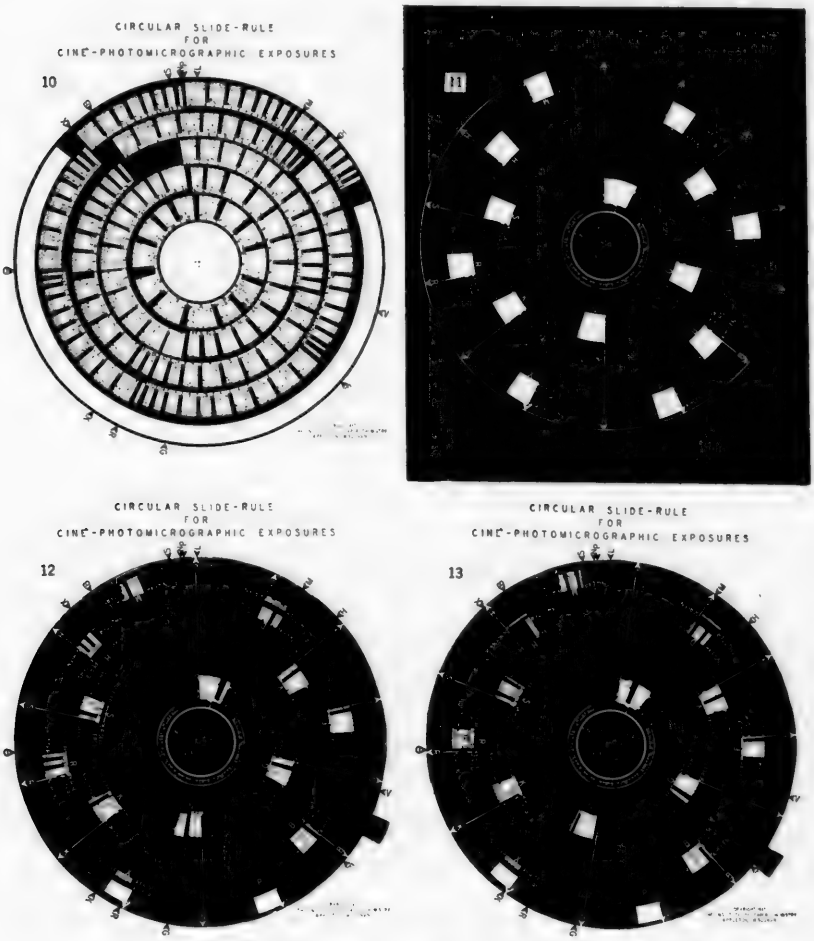
For each light intensity or standard exposure value there are thirteen different speeds or frames per second, three different openings of the shutter sector and four different intensities of the neutral screens. This is a total of 156 different exposure combinations without filters and makes the exposure determination quite complex.

As the product of the time and the intensity of the light must always be the same for a film of a given sensitivity for a properly exposed picture, there are only certain combinations of the shutter sector and screens that can be used for a given light intensity, and only a specific number of filters can be used in connection with these combinations.

Since this is true, the author has arranged all of these possible combinations for the fourteen different light intensities, "L" to "M" in the Instoscope, in a spiral as shown in Figure 10. The combinations for the highest light intensity, "L", are arranged in the inner circle. The others extend gradually outward so that the combinations possible for the lowest light intensity, "M", are in the outer circle. For each light intensity the possible shutter sector and screen combinations have been arranged separately for the different frames per second in such a way that one frame per second comes first and the number of frames per second increases clockwise around the circle. The possible selection of filters that can be used for each one of these combinations has also been

noted. The different light intensities as well as the different frames per second have been separated with heavy black lines.

A top plate shown in Figure 11 has been so arranged that the sectors (to be cut out) for the different light intensities are radially equidistant,




FIGS. 10–13

and the inner and outer parts of the sectors are the same distance from the center as the corresponding circles for similar light values on the bottom plate (Fig. 10). The width of all of the sectors is equal to the largest number of combinations for a given number of frames per second

in Figure 10. The light intensity corresponding to each sector cut out is designated with radial markings which correspond to a similar marking outside the outer circle of the bottom plate. Each sector also has designations as to where to read the number of frames per second, filters to be selected, shutter sector and screen.

When the bottom and top plates are cocentered on a pivot, as shown in Figure 12, and are arranged so that when the pointer on the outer circle for a given light value on the top plate is set against a corresponding mark outside the outer circle of the bottom plate, the cut out sector on the top plate for this value will show the possible filter, shutter sector and screen combination possible for this light value at one frame per second. In Figure 12 the top plate is set against a corresponding mark outside the outer circle of the bottom plate. The cut out sector on the top plate for this light value will show the possible filter, shutter sector and screen combination possible for this light value at one frame per second. In Figure 12 the top plate is also set against the bottom plate for a light value of "L" and 1 frame a second. The "L" sector shows that for this light value and number of frames per second the operator has the following combinations: B + H filter, shutter sector at 1 and neutral screen at 0.6; C4 + H filter, shutter sector at 1 and screen at 0.9; C4 filter, sector at $\frac{1}{2}$ and 0.9 screen; or H filter, shutter sector at $\frac{1}{4}$ and neutral screen at 0.9. Turning the top plate clockwise this cut out sector will successively show the combinations for 2, 3, 4, 6, 7.5, 8, 18, 24, 32, 60 and 64 frames per second.

With very low light values it will, of course, not be possible to take 60 or 64 frames per second; with a light value of "M" it is only possible to take 8 frames a second and then only with the shutter sector at 1, the neutral screen at 0.0 and a K1 filter.

Figure 13 shows the top plate set for a light value of "K" and 3 frames a second,with the following combinations for a perfect exposure: Hg/Gr'n Filter, sector at 1 and screen at 0.3; C5, F or B + G filters, sector at 1 and screen 0.6; A filter, sector at 1 and screen at 0.9; or no filter, sector at $\frac{1}{4}$ and screen at 0.9.

The combinations in this circular slide rule have been calculated for use with Ciné-Kodak panchromatic film. If films of different speed values are used, compensation for the differences in speed values must be made.

The author is indebted to Miss Eda Nihlen of The Institute of Paper Chemistry for assistance in this work.

REFERENCE

(1) WIELAND, M.: Ein Messverfahren zur Bestimmung der Belichtungszeit für die mikrophotographische Aufnahme. *Zeitschrift für wissenschaftliche Mikroscopie, 53:* 183–192, October, 1936.

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# VITAMIN D ASSAY ROUTINE*

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*Mt. Carmel, Conn.*

In the assaying of Vitamin D the biological method has been found to be the most accurate. It is at present the only method recognized by the United States Pharmacopoeia (1).

In the Vitamin D assay, normal rats not over 30 days old and weighing between 48 and 60 gms. are placed on a distilled water-Vitamin D free diet for a "depletion period" of eighteen to twenty-five days. At the end of this period animals to be used must show evidence of severe rickets by the line test described by McCollum (2) or by means of radiography. The rats are then assembled into three groups, namely:

1. The assay group
2. The reference group
3. The control group

Each group must consist of at least seven animals. The assay group is kept on the rachitogenic diet plus the cod liver oil diluted with Vitamin D free vegetable oil for an assay period of eleven days. The reference group is also kept on the same diet but is supplemented by a diluted, standardized cod liver oil obtained from the Government. The control group consisting of one rat from each litter is sacrificed before the assay period begins to determine whether severe rickets is present (Fig. 1).

On the eleventh day all assay and reference animals are chloroformed. Their hind legs are removed for dissection and staining to show the amount of healing affected by the Vitamin D. The amount is recorded in four degrees as shown in Figure 2.

* Received for publication February 19, 1938.

The potency of the oil is determined by dividing the daily dosage of the reference group by the daily dosage of the assay group and then multiplying the result by the known potency of the reference oil. For an oil to pass laboratory tests two-thirds of the animals in the assay

FIG. 1

group must have an average healing that is equal or greater than that of the reference group.

## X-RAY PROCEDURE

Before the assay and reference groups are placed on test the hind leg of each animal is x-rayed to show evidence of rickets. A rachitic bone has a broad, uncalcified area at the epiphysis. The unit used is a port-

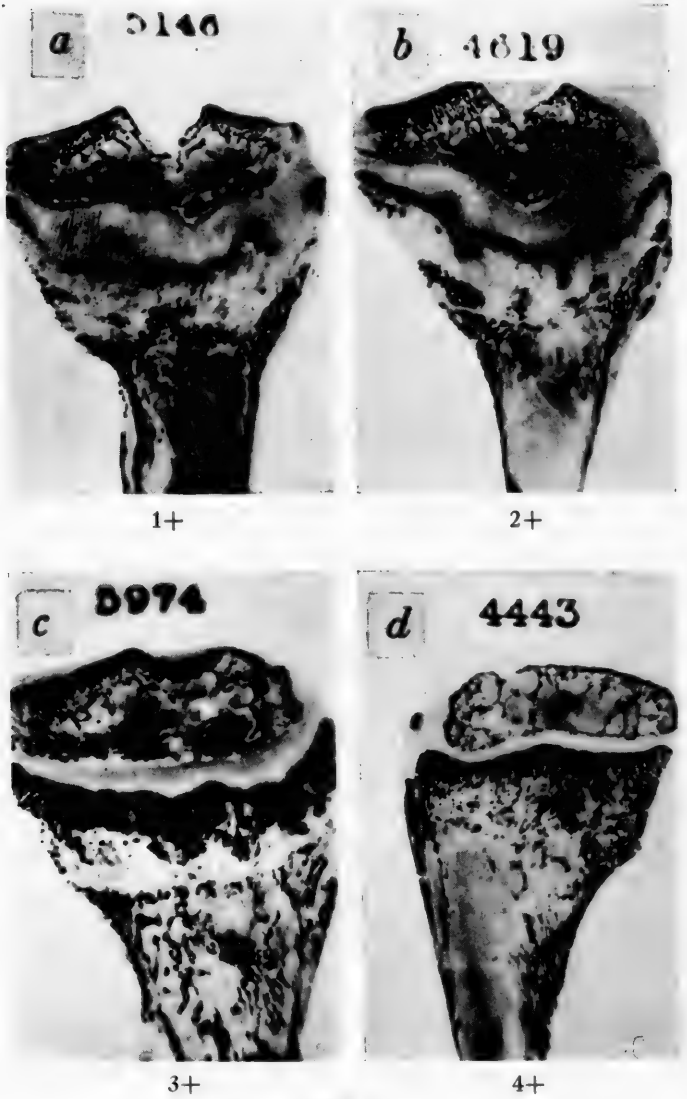


FIG. 2

able machine operating at 110–120 volts with an oil-cooled tube having an output of 75 kilovolts and 5 milliamps. With a working distance of 24 inches an exposure of a half second on Agfa high speed film is used.

## ASSAY REPORT PICTURES

As already stated, on the eleventh day of the assay period the animals are sacrificed and brought to the laboratory for dissection. After the removal of the hind legs at the knee joints, the superfluous flesh is removed from the tibiae. The tibiae are then placed in small vials containing 10 per cent formalin, to which are attached small, numbered identification tags. The formalin decolorizes the red marrow and hardens the cartilage so that when the bones are later split longitudinally and medially with a sharp razor it gives a good flat surface for focusing. In order to obtain this effect the bones are allowed to remain overnight in formalin.

On the following day the bones are split, washed in water to remove most of the formalin and then stained in a 2 per cent solution of silver nitrate for one minute. After a thorough washing the sections are placed in a small watch glass filled with water and then observed under the low power microscope in the path of a concentrated beam of light. Gradually the yellow silver combines with the newly deposited calcium of the bone and becomes black. This action takes place in two to three minutes and is carefully watched to prevent overreduction of the silver. The sections are then dipped into a regular photographic hypo solution for about one second to stop this excessive reduction. As only one bone section per animal is photographed for record, the one that gives the best average of the two tibiae and has the best contrast is selected. The one chosen is trimmed on the edges and the back as a final preparation for photographing.

In order to have the animal number appear on the negative with the section, a typewritten list of figures is photographically reduced with a view camera to a size that will be in proportion to the section when it is magnified in the final exposure.

After several attempts to obtain a good background to bring out the bone outline, an inverted opaque cold cream jar solved the problem. The sides of the jar were painted black to prevent possible reflection, and the small recess in the bottom served to hold water into which the bone and number strip were submerged. The proper angle of the lamp beam prevents reflection on the water surface. The pictures are taken with a Leitz "Macca" $\frac{1}{2}\times$ micro attachment camera with a $15\times$ Periplan eyepiece (Fig. 3). With light from a Bausch & Lomb microscope lamp epuipped with a 6 volt, 108-watt ribbon filament bulb at its brightest

point, a one-fifth second exposure on Eastman SS panchromatic film gives a normal negative. The film pack is developed for twenty-five minutes at 65°F in a No. 1 tank with D-76. The prints are made on Azo paper developed in D-72, and to improve their appearance a black border is employed.

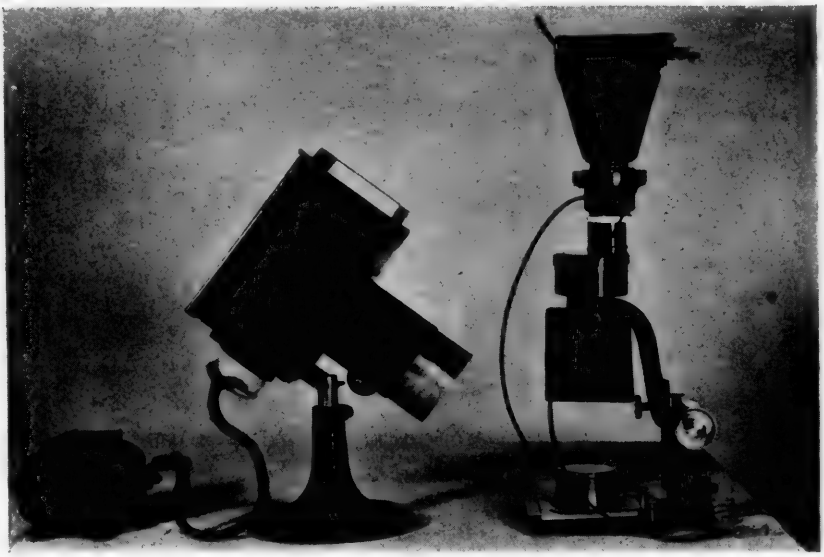

FIG. 3

Each vitamin D assay report is accompanied with copies of the x-ray prints and stained bone prints. In this way there can be no argument as those concerned can interpret the results themselves. As a further check, the bones are preserved in vials of formalin and stored for future references.

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(1) Pharmacopoeia of the United States, Vol. XI, p. 482–484.
(2) McCOLLUM, E. V.: *Jour. Biol. Chem.*, **65:** 97, 1925.

# MICROPHOTOGRAPHY*†

A. R. BARKER

*Rochester, N. Y.*

The growth of microphotography within the last few years is one of the greatest advances that the field of photography has ever seen. One of the reasons for this advance has been the use of the safety or cellulose acetate film, whose long lasting, fire resisting qualities make it ideal for this application. Anyone who commences work in microphotography should use only the safety film, and anyone who does start this fascinating work will continue with it and find new uses and new ideas around every corner.

Microphotography has been defined as the reproduction by photographic processes of manuscript or written material, reduced on the photographic emulsion so that some method other than direct visual examination is necessary to read the image. This definition distinguishes microphotography from its corollary fields—photomicrography and macrophotography; but it does not include all of the possibilities inherent in this new technic. The advantages of microphotography should be considered and from them can be determined the applications possible to this versatile technic.

## ADVANTAGES OF MICROPHOTOGRAPHY

There are four major advantages in the use of microphotography. These are (1) the preservation of ephemeral material, (2) the saving of space incurred by reducing material to small film, (3) inexpensive duplication of any material and (4) the dissemination of information in film form. All of these are important and taken together they form an impelling presentation of the potentialities of microphotography in any organization.

## PRESERVATION

The cellulose acetate or safety film has been commended by the National Bureau of Standards as eminently satisfactory for record purposes. Tests made by this organization, published in report R.P. 942, show that this film may be expected to last as long as record paper of the

* From the Folmer Graflex Corp.

† Received for Publication, April 30, 1938.

highest quality. It is therefore obvious that much of the material now stored in relatively impermanent form should be placed on film.

### SPACE SAVING

The problem of space is becoming more and more important in every organization. Material which now takes up a large amount of space can be reduced by more than 95 per cent in film form. The contents of thirty two filing cabinets can be stored in one cabinet. Five 300 page books can be reduced to one 100 foot roll of film measuring four inches in diameter and two inches thick. In other words, by this method, the space required for the storage of important records can be reduced in the same geometric ratio in which the records themselves are increasing.

### INEXPENSIVE DUPLICATION

Any desired material may be easily and quickly duplicated by the process of microphotography. The small size of the film used and the simplicity of the process reduce the cost of reproduction so that any material desired may be made available at a reasonable cost. The 35 mm. film used in most applications lists at $2.10 to $6.00 per 100 feet, depending on the type desired. Considering that 800 "double frame" or 1600 "single frame" pictures may be made on each 100 foot roll, the cost will be seen to be very low.

### DISSEMINATION

As material can be duplicated inexpensively it follows that the dissemination of such data is made more feasible and is relatively simple. Material of all types may be distributed in film form to any interested persons. The ease and inexpensiveness of the microphotographic method make it the perfect medium for the dissemination of much scholarly material.

### USES IN HOSPITAL AND LABORATORY

*Copying case records and other files:*

There are many applications for the use of microphotography in the hospital and laboratory. The copying of hospital case records, correspondence, and all business and organization files may be done easily, quickly and economically with this method. Such records become a real problem to many hospitals because of space limitations and lack of proper facilities for storage. Here the 95 per cent saving in space and the permanency of film make microphotography the obvious answer.

*Copying scientific articles:*

Scientific articles in periodicals, books and other publications may also be easily and quickly duplicated. Theses of students, monographs and similar material may be duplicated for distribution. Much of this material has a limited appeal, yet those interested should be able to obtain copies on film at a reasonable cost.

*Copying for projection:*

Visual education work is assuming increased importance in every field and particularly in the hospital field. Medical instructors can copy charts, graphs and pictures on small film and project them on the screen for classroom and lecture purposes. Health education can be taught most easily by this method. There is truth in the old Chinese proverb—"A picture is worth ten thousand words," and a picture presented on a screen can reach hundreds of people.

*Copying radiographic films:*

A very serious storage problem at many institutions is that of handling the radiographic films. Much of this early film has a nitrate base which makes it very dangerous to store and handle. The large size of the films requires special filing systems and considerable space and expense is incurred for their preservation.

Figure 1 shows an approved method of reducing x-ray films to standard 35 mm. film size. Mr. Herbert Mermagen, technician in charge of this work at the Strong Memorial Hospital in Rochester, New York, is shown ready to take the picture of the radiograph on the table illuminator. No light other than that from the standard type of x-ray illuminator is required and the speed of operation of the camera shown (the Graflex Photorecord) allows scores of these pictures to be taken in an hour. Eight hundred radiographs can be copied on one 100 foot roll of 35 mm. film. This film may then be used in the original, or preferably a positive print may be made which, when projected, will resemble the original radiographic film. Thus in a small space the hospital may have all of its radiographic reproductions stored for future use. Here they may be available for individual study, for projection on a screen, or paper prints may be made if desired. In this application at the Strong Memorial Hospital is recommended the use of Eastman Panatomic 35 mm. film to be printed on Eastman Ciné positive safety film for class room and lecture use.

*Photomicrography:*

Much microscopic photography can be done with small film, thus combining regular photomicrography with the advantages of micro-

FIG. 1. Copying radiographic films with the Graflex Photorecord

photography. Figure 2*b* shows Mr. Mermagen focusing for a picture of a microscopic subject. The magazine of the camera (Graflex Photo-

record) has been removed and placed on the base next to the microscope. A ground glass has been substituted for the magazine and the focusing is done directly on the microscope. The $2\frac{1}{4}''$ x $3\frac{1}{4}''$ Graflex back on the

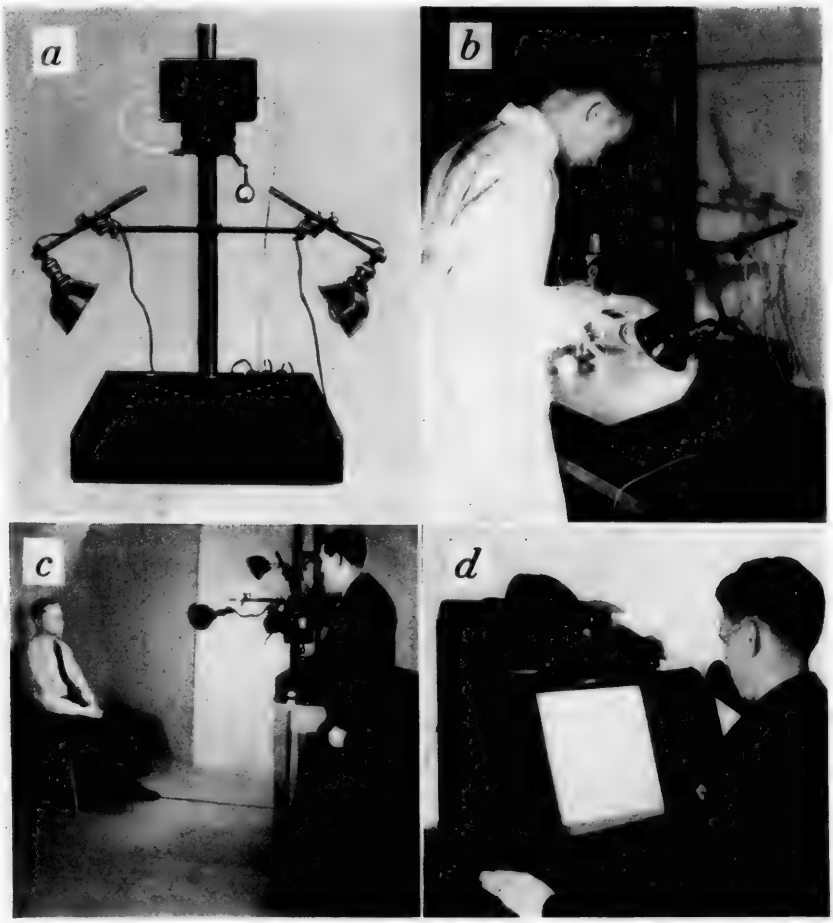


FIG. 2. *a*, The Graflex Photorecord; *b*, Photomicrography with Photorecord; *c*, Identification with the Photorecord; *d*, The Argus Microphoto reader.

Photorecord Camera also allows the use of $2\frac{1}{4}''$ x $3\frac{1}{4}''$ film holders, film packs and magazines, if a larger picture than 35 mm. size is desired.

## IDENTIFICATION

Another important use for small film is that of making identification pictures of employees, inmates in detention institutions and patients for case records. Employee passes are becoming increasingly popular in

many organizations and large hospitals and laboratories need the same method of identification. Inmates in criminal and detention institutions have always required identification pictures, but the cost of such pictures can be reduced as much as 75 per cent by the use of microphotographic procedure. Figure 2*c* shows the use of the Graflex Photorecord in this application. The size of the picture may be either "double frame" or "single frame" (35 mm.). If two pictures, full face and profile, are required as in criminal procedure, both may be taken on a double frame. The negative may then be enlarged to picture both views in one enlarging operation. The fine grain of the film used (Eastman Panatomic film is recommended) allows generous enlargement with little, if any, loss of detail.

The pictures of patients may also be taken very economically by microphotographic processes. Eastman 35 mm. Panatomic film is listed at $6.00 per 100 foot roll and as each 100 foot roll will accommodate 800 double frame pictures, the film cost of each picture is only three-fourths of a cent. This compares very favorably with the regular cost of negative material used in larger cameras. The speed of this operation with the Graflex Photorecord makes the labor cost a negligible item. It has been determined that such pictures should cost not more than two cents each when printed and ready to use on the case record. Successive stages of the recovery and cure of a patient are also very useful and make excellent case histories for lecture work. Hospitals would find also that such pictures offer a valuable legal aid in litigation connected with specific cases.

### OPERATION PHOTOGRAPHY

Many pictures of operations have been taken with movie cameras, small still candid cameras and with large prefocused telephoto lens combinations. Up to the present time, however, this work has been done by photographers working from galleries or, if on the floor, by special arrangement and under many difficulties. With the Graflex Photorecord such pictures can be taken by the surgeon himself or his assistant by merely stepping on the foot pedal which advances the film and actuates the shutter. Such pictures are extremely valuable to the surgeon for lecture and classroom use.

### VISUAL EDUCATION AND WELFARE WORK

Many patients cannot move from their backs, others cannot hold books and cannot read but do enjoy pictures. For such patients a

simple projector may be used to show films of books and pictures of interest to sick people. For those who cannot rise the ceiling may be utilized as a screen; for others a wall or small screen is sufficient. These films may be extremely useful and in many cases have a definite curative and educational effect.

## CAMERAS

There are several cameras which may be used for this work. The so-called candid cameras, such as the Bantam, Leica, Argus and Contax, use 35 mm. film and are perfectly satisfactory for the major usage of scenic picture taking and for occasional copy work. However, for laboratory work and for copying of more than a few sheets at a time a more highly mechanized unit is required. Such an apparatus is the Graflex Photorecord. This highly efficient, versatile camera may be used for copying any material from the size of a postage stamp to a full newspaper page. Its operation is simplicity itself. A simple pressure of the foot pedal intensifies the lights, advances the film and actuates the shutter. Thus, both hands are left free to hold the subject or to turn the pages of the book or manuscript. Its versatility allows it to be used for regular copying work, for identification purposes and many other applications. Its ability to accept $2\frac{1}{4}''$ x $3\frac{1}{4}''$ film in film holders, film packs and magazines allows its use for copying of large subjects or taking large negatives when required.

## UTILIZATION

For momentary examination of one picture of the film or for reading the reproduction of one page of a book or similar material a small magnifying glass may well suffice. Small glasses may be obtained from 59¢ to $12.50, depending on the magnification and freedom from distortion and aberration that is desired. For more convenience, for less eye strain and for projection to a screen a small projector such as the S.V.E. Picturol may be used. This instrument sells for $32.50, will project a fairly clear image and is small enough to be readily portable.

For maximum versatility and clarity, however, the new Argus Reader is recommended. This apparatus projects an image that is enlarged twelve times on its translucent screen. It will also show film photorecorded either parallel or at right angles to the edge of the film, and by raising the front mirror it may be used as a projector for lecture or class-

room work. This new reader distributed by Graflex as a companion item to its Photorecord camera sells for only $75.00 in the United States and is a useful, efficient addition to any desk or office. Figure 2*d* shows its neat design and the simplicity of its operation.

Microphotographic film may, of course, be enlarged just as any miniature negative may be printed in the size desired. The Graflex Enlarg-or-Printer serves ideally for the making of clear, legible copies of Photorecord films.

## COSTS

The costs of microphotography can be broken down into five factors,—the camera, the film, the labor of taking the picture, the developing and the reading machine or printer.

Less expensive cameras may be obtained but the efficiency of the Graflex Photorecord makes it the ideal choice for any hospital or laboratory. This camera sells for $265.00.

The film recommended for this work varies from Ciné positive to Panatomic, with prices ranging (list) from $2.10 for the positive film to $6.00 for the Panatomic. Kodachrome may also be used in the Photorecord and is now available in 15 foot lengths at $1.00 per foot. This opens up fascinating possibilities for the microphotographic worker.

The labor cost of each job must of necessity vary with the job and with the operator. When using the Graflex Photorecord as many as 1,000 cards or single sheets may be photorecorded in an hour. Bound volumes, fragile objects and other subjects will, of course, take longer. Other cameras without the mechanized operation of the Photorecord do not have the speed advantage which it enjoys.

Developing may be done in short strips by the usual tray method, with small tanks for long strips and with Stineman spiral reels or similar systems for 50 or 100 foot lengths. A stainless steel spiral reel capable of holding 100 feet of film may be obtained for $30.00 (list) and a set of three nested tanks with a winding device for $20.00 additional. These accessories will be found very useful for anyone doing production work in microphotography.

It is also possible to have the developing and printing of such films done by photofinishers. The Graflex Corporation has prepared a list of photofinishers in all sections of the country who are in a position to handle long rolls of 35 mm. film. Their prices range from $1.00 to $3.00

per 100 foot roll for developing, and from $4.00 to $6.00 for printing on positive film. Enlargements may also be obtained at reasonable prices.

Magnifiers, projectors, reading machines and enlargers have been mentioned before and their cost depends entirely upon the necessity and financial ability of the purchaser. The Argus Microfilm Reader at $75.00 and the Graflex Enlarg-or-Printer at $87.50 are recommended. The latter unit is extremely versatile. It may be used as a contact printer and enlarger and even as a retouching desk, and accepts the Photorecord film as well as larger sizes up to $2\frac{1}{4}'' \times 3\frac{1}{4}''$ or an equal section of a $4'' \times 5''$ negative.

### CONCLUSION

It is obvious that microphotography has many advantages and many uses in the hospital and laboratory. It need cost very little and its utilization may be dependent on the need of the user. Microphotography is comparatively young, but it is a lusty infant and due for a great future.

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RANEY, M. L.: Microphotography in Libraries, (Yearly) 1936–1937.
TATE, VERNON D.: Journal of Documentary Reproduction (Quarterly).

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## PHOTOGRAPHIC TECHNIC, NEW PROCESSES, AND EQUIPMENT*†

F. R. HARDING

*Boston, Mass.*

### LOW LEVEL FOCUSING BY REFLEX MIRROR

In some institutions much clinical photography is done with the patient seated or standing upon an examining bench. This necessitates a considerable amount of kneeling on the part of the photographer in order to properly focus the image on the ground glass of the camera. A reflex mirror may be fitted to any camera which utilizes a swingback or which has a space between the camera body and the camera base. The mirror may be firmly fixed in this position by very slightly rotating the swingback and locking it in position. The mirror is readily detachable when its use

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* From the Department of Photography, Children's Hospital.
† Received for publication April 19, 1938.

is not desired. This arrangement is an adaption of the apparatus described by Schmidt (1) for use with the vertical photomicrographic apparatus. The mirror is set at an angle of about 50 degrees.

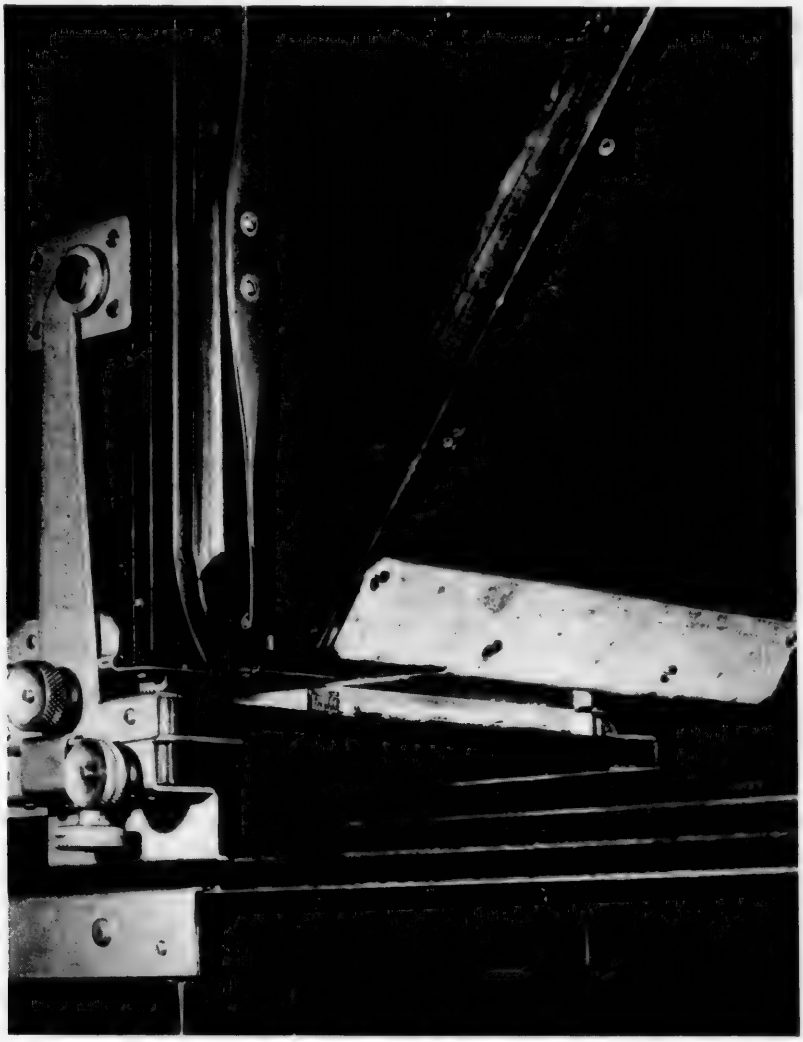

FIG. 1. Reflex Mirror in Position

The reflex mirror used at the Children's Hospital in Boston is a thin plate glass mirror which is set in a substantial wooden frame. The outside dimensions of the frame are 8″ x 8½″. At one edge of the wooden frame is fixed a piece of heavy gauge

sheet metal. At the outer end of this sheet metal is affixed a piece of solid metal $\frac{3}{8}$ of an inch thick and $1\frac{1}{2}$ inches in width. All measurements should be taken with the film holder inserted in position. The thick metal which is employed as a filler may be sufficiently long to fit loosely between the swingback gears at the left and right of the under side of the camera, or it may be a short section with two wooden guides fastened to the base of the camera as in Figure 1. A strip of metal of the same thickness as the metal reinforcement on the bottom of the ground glass carriage is placed on the right side of the carriage so that the camera back will be plumb in either the vertical or horizontal position. The swingback shaft is employed as a back stop for the inset. To avoid scratching the camera the metal inset must be covered with cloth. The mirror may also be employed for high level focusing with the camera in a vertical position. A reflex mirror of this description has been employed by the writer for the past two months and has saved much time when feet, legs and sitting figures are photographed on the examining bench and when full length figures are photographed standing on the floor. The mirror also has the advantage of reflecting the image right side up.

*Reference*

(1) SCHMIDT, LOUIS: Photomacrography. *Jour. Biol. Photo. Asso.*, Vol. VI, No. 2, p. 48, Plate 1G, 1937.

### SIGNS BY PHOTOGRAPHY

A simple method of making small signs involves the employment of a movable letter, slotted board of the type used for restaurant menus. The reading matter for the sign may be set up with white celluloid letters on the slotted board and photographed on process film. Projection prints may then be made to any size desired. Each print can be mounted and framed and will produce a neat and serviceable sign. The background is black and the letters are white. Signs made by this method may be produced rapidly.

### 16 MM. ARC PROJECTOR ANNOUNCED BY BELL & HOWELL

Again the scope of 16 mm. film is extended. In announcing the new Filmoarc sound film projector, which employs an arc lamp for 16 mm. film illumination, Bell & Howell seem finally to have released the heretofore latent possibilities of 16 mm. film. Sufficient light is available for projecting brilliant images from 16 mm. film, color or black-and-white, in even the largest of auditoriums.

The Filmoarc was designed from the start as an arc projector. The motor is in front of the film moving mechanism. A new and highly efficient ventilating system was developed particularly for this model. The high intensity electric arc is formed by two carbons which are automatically positioned by an electric control system that maintains a constantly uniform gap.

Both sound and silent (24 and 16) film speeds are provided, so that either type of film may be shown at the proper operating speed. Film reels as large as 1,600 feet are accommodated. Film rewinding is done by a secondary electric motor and without operating projector mechanism, projector motor or arc lamp.

The Filmoarc amplifier produces an undistorted output sufficient for the largest

auditorium. All adjustments for sound regulation and projector mechanism control are centralized upon the sloping control panel of the amplifier, where provision is made for operating twin projectors with theaterlike smoothness of changeover. Provision is made for using the latest type crystal microphone. Two heavy-duty, high fidelity, permanent magnet speakers are standard equipment.

Two models are offered. One provides a roll away stand which supports projector, amplifier and rectifier. The other, even more compact when packed for transportation, mounts the projector upon a stand having adjustable legs, while the amplifier rests upon a smaller stand directly beneath. The rectifier is located below the amplifier.

# Association News

EIGHTH ANNUAL CONVENTION

The Eighth Annual Convention of the Biological Photographic Association will be held at the Hotel Warwick, 17th & Spruce Sts., Philadelphia, Pa., on September 15, 16 and 17, 1938. The Hotel Warwick is situated centrally and convenient to all means of transportation. The ballroom and foyer of the hotel have been assigned to the Association for the assembly room and the exhibition of the Annual Salon.

The facilities of this hotel are excellent for the convention. The accommodations are such that they will be able to take care of any size group without inconvenience and there will be ample space for exhibits. Because of the abundance of space the *Philadelphia Chapter* would like to have as many members of the national organization as possible contribute material to the Salon. Prints do not necessarily have to be mounted; the Salon Committee will be glad to do the mounting if anyone desires it. Since a special feature of the meeting is the Salon, members are urged to assemble prints for exhibition as soon as possible so that there will be no delay at the time of the meeting. The Chairman of the Salon Committee is Dr. M. A. Dillman, Jefferson Medical College, Philadelphia, Pa., who is assisted on the Committee by Mr. Leo C. Massopust, Dr. Adrian W. Voegelin, Mr. Joseph B. Haulenbeek and Mr. Charles Zahn. Please communicate with Dr. Dillman with respect to information concerning the Salon, since it is necessary that he know well in advance the number who are submitting prints for exhibition so that arrangements may be made to fit them into the general exhibit layout.

All members of the Association are urged to communicate as soon as possible with Mr. William J. Taylor, Temple University Hospital, 3401 N. Broad St., Philadelphia, Pa., Chairman of the Program Committee, in the event that they wish to contribute papers to the forthcoming meeting. The following members are assisting Mr. Taylor in the program: Dr. E. S. Gault, Mr. Emil Forney, Mr. John F. Frank and Mr. R. G. Burton.

The Philadelphia Chapter is looking forward to the convention with a great deal of enthusiasm and every effort is being exerted to make it successful. However, you, as members, must contribute your share if full success is to be achieved. Consequently, it is necessary for you to indicate your willingness to contribute papers or other interesting material of photographic value to the convention. This Chapter is now well organized and running smoothly. It enjoys excellent attendance and the meetings to date have been interesting and instructive. The members have discussed color photography, photomicrography, photography of patients and specimens, and the use of the miniature camera in medical photography.

* * * *

The Executive Board met at The Rockefeller Institute for Medical Research on Saturday, April 23, at which time the entire matter of the future of the Journal was thoroughly studied.

On June 14 Mr. Ralph P. Creer will address the photographic section of the Commonwealth Club of California, San Francisco, Calif., on the subject of "Biological Photography as an Aid in Modern Medicine."

* * * *

Last April Mr. Leonard A. Julin presented a paper on "Clinical Photography" at the Center for Continuation Study at the University of Minnesota, Minneapolis, Minn.

* * * *

On Wednesday, May 4, the Pittsburgh Chapter elected the following officers to serve during the coming year:

| | |
|---|---|
| Chairman | Mr. Graham Netting<br>Carnegie Museum |
| Vice-Chairman | Dr. Mortimer Cohen<br>Associate Professor of Pathology<br>University of Pittsburgh |
| Secretary-Treasurer | Miss Anne Shiras<br>Department of Medicine<br>University of Pittsburgh Medical School |

At the April meeting, Mr. Herbert Spencer, President of the Pennsylvania College for Women, presented a number of color slides exposed during a recent trip to Europe. Some of these slides were made on Eastman Kodachrome film, the others on Agfa color film.

The Pittsburgh Chapter is indebted to the following individuals for contributions to its programs during the past year:

Mr. Lloyd Varden, Agfa Ansco Corp., "High Speed Emulsions."

Mr. Harry Kirby, Defender Photo Supply Co., "Demonstration of the Chromotone Method of Color Printing."

Mr. Byrsdorfer, Eastman Kodak Co., "Negative Quality."

Mr. Nicholls, Eastman Kodak Co., "Print Quality."

A representative from the Fleischmann Yeast Company projected an interesting film on the subject "Growth of Yeast."

* * * *

The newspapers want more science pictures. This is a part of a drive to feature a greater number of authoritative, up-to-date stories on scientific research. In *Medical Economics* for December, 1937, the reporters' aims are summarized as follows:

> "... establishment of a medical news clearing house; a more generous supply of medical news pictures; direct reporter-doctor contacts; 'medical police cards' for qualified newsmen; no censoring of medical news; more awareness by physicians of the public welfare phase of medical news and less apprehension of its effect on individual doctors; organization along professional lines of the dailies' news and editorial departments."

Waldemar Kaempffert, Science Editor of the *New York Times* and President of the National Association of Science Writers, has suggested that the American Medical Association appoint a committee for further discussion of the medical reporting prob-

lem. There will be a period of conferences and arguments, during which the pressure for popularization will lock horns with traditional reticence. Inevitably the outcome will be a greater degree of cooperation between scientific bodies and recognized publications. Meanwhile it is advisable to begin practising up for bigger and better publicity, for pictures will be telling the story wherever possible.

* * * *

Dr. O. W. Richards, Research Biologist of the Spencer Lens Company, Buffalo, N. Y., will give a series of Saturday lectures at the Allegheny School of Natural History this summer.

* * * *

In a report from Miss Florence Melvin, who has charge of the distribution of the albums of the Association, we learn that the albums have been in considerable use during the past year. It is a very favorable indication that examples of the work of the Association are widely used for comparison purposes.

* * * *

The Boston Chapter reports very promising growth and interest among its members. In January, Professor C. T. Brues of Harvard University entertained the Chapter members with 16 mm. motion pictures made on a recent trip to the Dutch East Indies. About 4,000 feet of film were shown which depicted the native and animal life of that country. After the meeting refreshments were served and all those present had a most enjoyable evening.

The February meeting was held at the Harvard Dental School. Motion pictures of the Hindenberg Disaster were shown. A discussion of "a reasonable scale of photographic prices" also took place.

The March meeting was held at the Children's Hospital. Mr. F. R. Harding gave a talk and demonstration on the use of illumination in medical photography.

The April meeting was also held at the Children's Hospital, where Mr. Sheldon of the Agfa Ansco Corp. presented a talk on new color plates and their manipulation, after which he showed about 200 examples which he had made in and about New England.

An inspection of the Edgar Station of the Edison Electric Illuminating Company, as guests of Mr. Wellington, comprised the May meeting. This excursion was an exceedingly profitable one in every way and further details of it will appear in the next number of the Journal.

Mr. F. R. Harding published a paper on "The Organization and Equipment of a Photographic Department" in the April number of *Radiography and Clinical Photography*.

* * * *

Mr. Wm. F. Payne read a paper on "Photography in Medicine and Research" at the Buffalo Academy of Medicine on January 26. On May 2 he presented a paper on the subject of "X-ray and Photography in Criminology" before the Maimonides

Club of Buffalo, N. Y. In a forthcoming number of *Medical Economics* a paper by Mr. Payne on "Photography in Medicine" will be published.

* * * *

Mr. Payne is spending the summer at the Jackson Memorial Laboratory, Bar Harbor, Maine, where he will be engaged in photographic work for research purposes.

* * * *

A paper by Mr. Jean Kieffer, describing in detail the function of the laminagraph, was published in the April, 1938 number of *The American Journal of Roentgenology and Radium Therapy*. Mr. Kieffer is planning to attend the American Medical Association meeting in San Francisco, where no doubt he will be in a position to demonstrate the very ingenious apparatus (the laminagraph) of which he is the inventor.

* * * *

We welcome to the Association the following new members and hope they will attend the convention in Philadelphia this fall:

Abramson, Paul D., M.D.,
North Louisiana Clinic,
1130 Louisiana Avenue,
Shreveport, La.

Cloudman, Arthur M., M.D.,
Hancock Street,
Bar Harbor, Maine.

Cook, Thomas, J., D.D.S.,
4001 Spruce Street,
Philadelphia, Pa.

Council, Captain Francis E.,
School of Hygiene,
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* * * *

The First International Photographic Exposition, held April 18–24, occupied one entire floor of the Grand Central Palace in New York City. It was a huge success. Beginning with an historical section, the scope of photography was entirely covered from the time the first photograph was made up to the present day. There were practical demonstrations of photographic technic on the stage. In the auditorium lectures on photographic subjects were given, accompanied by lantern slides and motion pictures. Science was represented in an extensive way by exhibits from the New York Microscopical Society and by those of our Association. A large part of the Rochester (1937) Salon was hung; there was not space for all prints from previous salons but a fair portion of the work of each was placed on exhibit. The following

are the names of those whose prints were accepted for purposes of exhibition at this meeting:

Mr. J. A. Carlile, Princeton, N. J.
Mr. Philip O. Gravelle, South Orange, N. J.
Mr. Leo C. Massopust, Milwaukee, Wis.
Mr. C. G. Eddy, Eloise, Mich.
Mr. Frank N. Ruslander, Detroit, Mich.
Mr. Richard W. St. Clair, Boston, Mass.
Mr. Wilbour C. Lown, Boston, Mass.
Mr. Ferdinand R. Harding, Boston, Mass.
Dr. Julian M. Bruner, Des Moines, Iowa.
Mr. H. S. Hayden, Montreal, Canada.
Mr. Adolph Marfaing, New York City.
Mr. Louis Miller, New York City.
Mrs. Katharine W. Kingsbury, Pelham Manor, N. Y.
Miss Stella Zimmer, Syracuse, N. Y.
Mr. Louis P. Flory, Yonkers, N. Y.
Miss Florence Melvin, Columbus, Ohio.
Mr. Glen Mills, Denver, Col.
Dr. Bruce Mayne, New York City.
Mr. Louis Schmidt, New York City.
Mr. Joseph B. Haulenbeek, New York City.
Mr. Stanley J. McComb, Rochester, Minn.
Dr. Robert Von der Heydt, Chicago, Ill.

* * * *

The Salon has recently been shown in Columbus, S. C. and Hamtramck, Mich. From there it will proceed to Mt. Carmel, Conn., Boston, Mass. and White Plains, N. Y.

* * * *

The New York Chapter held its last meeting before the summer recess on May 31 in Squibb Hall, Fifth Avenue at 58th Street. Dr. Frederick J. Maisel demonstrated his method of "Clincal photography in natural color with contax and contameter using photoflash". This demonstration proved very interesting to the members present and called forth a lively discussion, including a number of suggestions which the speaker highly appreciated. It was illustrated by slides on Kodachrome film. The apparatus used was one devised by the speaker and consisted of camera and flash bulbs mounted together on a bracket which the photographer held in his hand in making the exposure. The pictures were mostly made in the operating room during the operation. In some cases the apparatus was brought as close as eight inches to the operating field. The discussion was followed by a business meeting in which the treasurer's report showed a balance of about $40.00. The following officers and directors were then elected.

Chairman, Mr. Lester V. Bergman
Vice-Chairman, Mr. Francis J. Johlfs
Secretary-Treasurer, Mrs. Audrey Hollander Israel

Directors:

Dr. George H. Semken.
Mr. Joseph B. Haulenbeek.
Mr. John F. Brooks.

All of these directors were on the governing board last year. It is expected that the new board will inaugurate a lively group of meetings beginning with one early in September. It is hoped and expected that the Chapter may again have the use of Squibb Hall, which has been so generously donated by the firm of E. R. Squibb & Son.

*Arthur W. Fuchs*
*343 State St.*
*Rochester, N. Y.*

Forestry

# The Journal of the Biological Photographic Association

*Official Publication of the Biological Photographic Association*

VOLUME 6 NUMBER 4

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*June, 1938*

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# The Journal of the Biological Photographic Association

*contains articles on*

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Cinematography
Cinemicrography
Clinical and Gross Photography
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Processing Room Technic
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*Published Quarterly*

THE PURPOSE of this Journal is to keep the biological photographer posted in the latest developments in photographic technic, and the proper use of equipment and materials in relation to the biological sciences. It contains articles by authorities in the fields of biological photography which tell, in simple language, how to obtain what are ordinarily considered difficult pictures in the easiest possible manner. They discuss new equipment and its uses. The Journal publishes pictures and articles on advanced photographic apparatus constructed by the research workers in the photographic departments of the foremost American and foreign Universities, including Medical and Dental Schools.

It is the most complete source of technical information for the biological photographer. The dues of a member of the Biological Photographic Association are $3.00 per year, of this amount $2.00 is for a year's subscription to the Association's Journal. For non-members of the Association the subscription price is $3.00 per year or $.75 per copy.

If you are a producer of any type of biological photography, if you photograph anything that is alive or has been alive this association and publication will help you to advance in your profession. It will be to your benefit to mail your subscription to the address below or become a member of the Association and receive the Journal entitled to you by membership. See the back cover for the address of the Secretary of the Association when making application for membership.

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All matter concerning the Association should be sent to Miss Anne Shiras, Secretary, University Office, Magee Hospital, Pittsburgh, Pa.

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